REPORT

OF A

Commissioner of Fisheries

OF

MARYLAND.

JANUARY, 1878.

BALTIMORE:
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1878.

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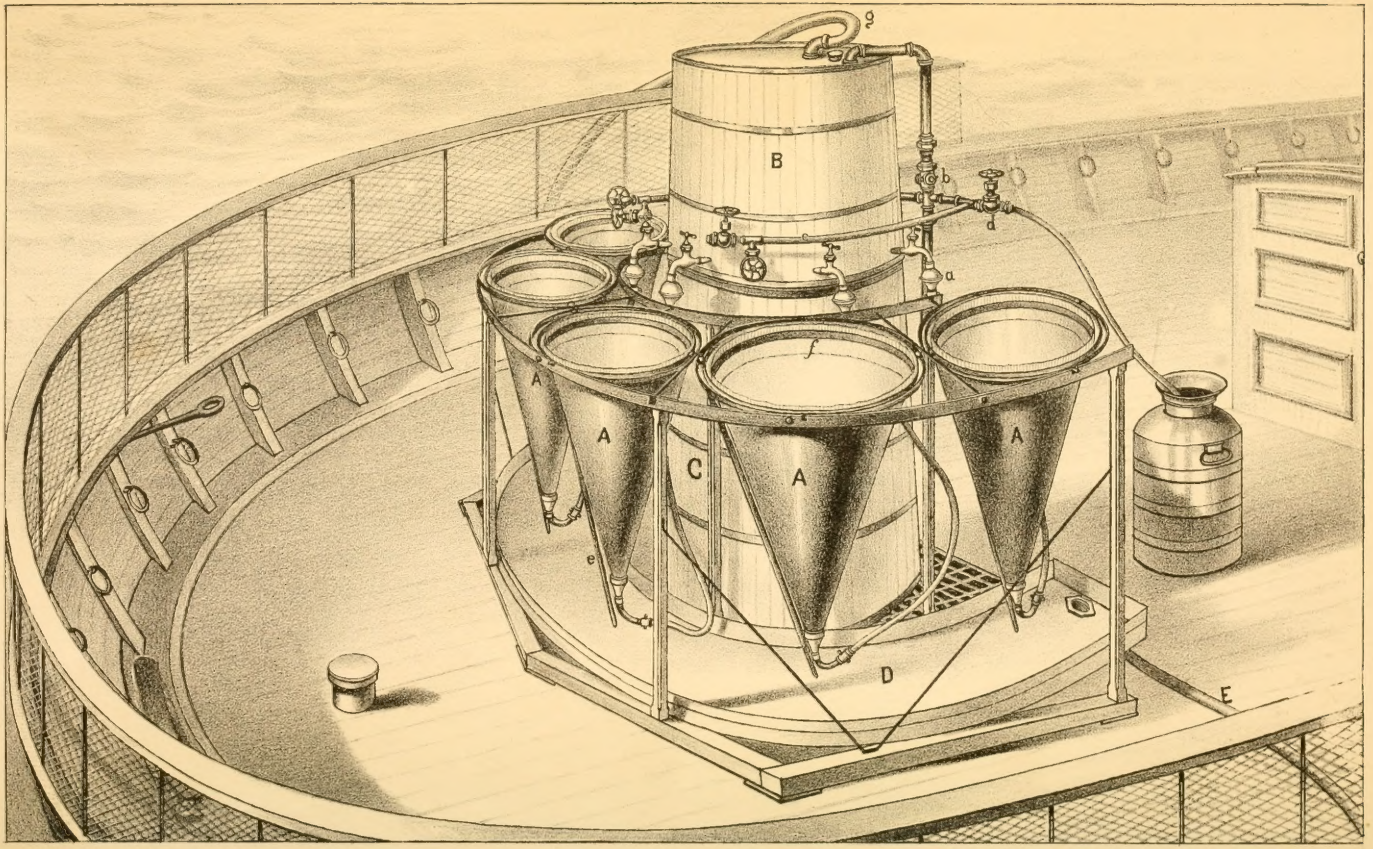
COMMISSIONER.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REPORT.

To his Excellency,
JOHN LEE CARROLL,
Governor of Maryland:

I have the honor to report, in pursuance of section 4, chapter 47, laws of 1876, "the work accomplished by the Commission" during the year 1877, and to make a few "suggestions for the protection and propagation of the food fishes of the State," as the result of my observation and experience during the four years of service as Commissioner of Fisheries.

The past year has been a most important one, to the fishing interest especially, as producers, and to the country at large, as consumers of fish, on account of the many indubitable proofs which have accumulated, showing the correctness of the theories on which most of the efforts to restore depleted waters with the valuable fishes, which were once abundant, but had either entirely disappeared, or had become alarmingly scarce, depended for success. On the correctness of these theories depended also the success of any efforts to stock waters with migratory fishes, which had before been unknown to them. The year 1877 will be noted as adding confirmations so strong that even the hitherto most skeptical can no longer doubt the unerring certainty with which the anadromus fishes (these fishes which move up the rivers to spawn,) return, when adult, to the river in which they had spent their minority. That this was the habit of the Salmon, had been demonstrated both in Europe and in this country, as great numbers had been marked and found to

return to the same river, year after year; but the experiments had in a great measure, been confined to rivers or localities in which the Salmon had been previously found During the year just ended, we have had many proofs that this instinct is so strong that the Salmon will return to rivers, in latitudes in which they had never existed prior to their artificial introduction as young fish.

Mr. Wilmot, Fishery Officer of the Dominion of Canada, writes me: "California Salmon have visited my establishment this Autumn for breeding purposes."

Hon Theo. Lyman, Commissioner of Mass., writes: "The most striking and rapid restoration of a partially exhausted fish, was that of our common Smelt, (*Osmerus*), which we value much, and which we again have in its former size and abundance.

A very important fact is the return this year, and for the first time, of large numbers of adult Salmon, (*S. salar*), the progeny of artificial culture, to the Merrimack river.

Small lots of Salmon parrs had been placed in the upper waters on several occasions previous to 1872. In that year, 16,000 were put in; and in 1873, 185,000.

This year (1877,) we ordered our agent at Lawrence, to shut the water from the great fishway *daily*, and see what was in it at the moment of closing.

On May 31st, he found two Salmon of 8–12 lbs. weight. On June 4th, a 15 lb. Salmon. From June 10th to July 10th, there were found, almost daily, from 1 to 5 large Salmon in the act of passing the way at the moment of closing. They penetrated to the very head-waters, among the White mountains, and were seen shooting the falls in numbers. Many were taken, for a moment, in a net and examined, and were found to be high-fed, silvery fish of the first quality."

Dr. Wm. M. Hudson, of Connecticut, adds the following testimony to the return of the Salmon: "The young of the *Salmo salar* from Bucksport, first introduced in 1871, ap-

peared as Smolts within two years after their introduction, and specimens were easily obtained. About a dozen of the adult fish have been taken in the Connecticut river during the past season."

But to us in Maryland, of more importance is the re-appearance, in the Delaware, of Salmon of both varieties: the *Salmo salar* of the northern Atlantic coast, and the *Salmo quinnat* of the Pacific. I have received authenticated accounts of the capture of one weighing 8½ lbs., at Newcastle; one, 8¼ lbs., at Riverton; and one weighing 9 lbs., taken between Bordentown and Trenton; and have myself seen a large female Penobscot Salmon, with the mature eggs running from her, which was taken near Easton, in the act of spawning; there have been several others reported, even weighing as high as 20 lbs. These indications of the successful introduction of the Salmon into the Delaware, commenced two years prior to the establishment of a Fish Commission in Maryland, strengthens our hopes and confidence in the results of our efforts, as the Delaware is not so unlike our own rivers, and not in so different a latitude but that we can reasonably expect a like result. More important to us still, than the accumulated evidences of the laws which govern the migrations of the Salmon, are the proofs which have been added during the year, that these laws are as surely applicable to the migrations of the Shad

It may be possible to attribute the return, in comparatively large numbers, subsequent to artificial propagation of Shad in a river, while in adjacent rivers they continued to decrease, to other causes than the production of a large number of young fish, which, without artificial means would have been entirely destroyed. It is impossible, however, to account for the sudden appearance of Shad in a river in which they had not hitherto existed, but in which young Shad, artificially propagated, had been placed, on any other theory than that of their return to the waters of their youth,

impelled by the same instinct which has been so clearly demonstrated as governing the Salmon. Such unmistakable evidence have we in the capture of several hundred adult white Shad, *Alosa sapidisima*, in the Ohio river last spring, since prior to their introduction in 1872, by the United States Commissioner, this most valuable fish was unknown to the Mississippi river, or any of its tributaries. Add to this the successful introduction of Shad into the rivers of the Pacific slope, and we are forced to the conviction that the same laws are applicable to the return of the Shad as to the Salmon, viz: that they will return as adult to the waters in which they are placed when young.

On page 22 of the report of the Commissioners of Fisheries of the State of California for '76 and '77, they say: "Shad, in their season, are becoming quite numerous in the Sacramento river. The experiment of their importation to this coast has resulted satisfactorily. The river is of proper temperature, and furnishes an abundance of food for the young fish before they go to the ocean. There can be no doubt that the first Shad brought from the Hudson river, in eighteen hundred and seventy-one, have been to the ocean, returned and spawned."

The introduction of Shad into the rivers flowing into the great lakes has also proved as completely successful, although it was feared that they would not find in the fresh waters of the lakes, conditions as suitable as in the salt water of their accustomed abode in the Atlantic. During the past season, many fine large specimens, weighing as much as five and a half pounds, were taken in the tributaries of Lake Ontario. The dates of the original deposit of the young fish in the waters in which they had hitherto been unknown, and the times of their subsequent re-appearance as adult, give us some evidence, also of the probable growth, of the variety of fish. In these instances of the successful introduction of Shad in California, in the Ohio and in the Great Lakes, the first deposits having been made in 1871, 1872 and 1871 respect-

ively, indicate, that with the Shad at least, that they do not return from the sea in numbers as adults before the 4th, 5th, or perhaps the 6th year. The imperfect means of observation causes these deductions to be mere conjecture, but sufficiently important to sustain hope and confidence in the ultimate successful results from efforts to re-stock our waters with this valuable fish, even though no decided increase is observable for four or five years after the initiation of the work. In judging of the efficiency of the means employed to re-stock our waters with Shad, we must not lose sight of the fact that there has been an enormous, alarming and steady *decrease* in the yield of our Shad and Herring fisheries since forty years back, when the catch on the Potomac in *one day* was equal to the entire catch of last *season*. Surely, if this decrease can be arrested only, even if there is no marked increase for several years to come, the work of artificial propagation, as yet scarcely more than begun, should be prosecuted with the utmost energy.

It was not to be expected that we should have any positive evidence of the success of the introduction of Salmon, or the increase of Shad, resulting from young fish artificially propagated and placed in our waters, as a sufficient time has not elapsed since the commencement of the work in Maryland; but we are not without indications of what will be the result of continued efforts to increase our fish yield. As it has been pretty well ascertained that the male Shad are adult, and run up the rivers a year sooner than the females of the same brood, which are not mature until the 3d or 4th year, I looked with some certainty for an increase of numbers in the Bay of smaller male Shad, consequent to the return of some of the males of the one million seven hundred and ninety-five thousand turned loose in the Chester river, and the two million three hundred and fifty-five thousand turned loose in the Patuxant during the spring of 1875. It having been observed with the Salmon, that the youngest fishes arrive earliest in the season, but do not penetrate far the first

year, I thought it most likely that the return of the young Shad would first be noticeable in the Bay, so visited the Annapolis Fish market on Saturday, April 21st, and examined many of the fishermen operating the large pound nets in that locality, and the universal testimony given by them was that the catch of small "buck Shad" had been larger than known for many years, some asserting that they had not taken so many male Shad for twenty years, while the females were not more abundant than in previous seasons. If this increase in the number of males is attributable to the operations on the Chester in 1875, as we have every reason to believe that it is, a corresponding increase in the females can be looked for during the coming seasons.

The great success attained by artificial means in the Connecticut, Hudson and other rivers, has already been instanced in my previous reports.

The National Museum at Washington, has a case devoted to the preservation and exhibition of specimens, showing the success in stocking waters of the country with fish by artificial methods. This case is constantly, almost weekly, receiving additional specimens from all parts of the country, testimonies to the successful efforts of Prof. Baird, United States Commissioner, and of the several State Commissioners.

Apace with the accumulation of evidence to the correctness of these theories, on which the efforts to increase the fish-food resources of the country were based and the proofs of the good results already attained from these well-directed efforts, is the progress which has been made during the year in the methods, and the improvements in the apparatus employed and necessary for the successful prosecution of this important industry.

In other States, there have been several important improvements made in the apparatus used during the development artificially of the ova of fish, and in the methods of packing eggs for transportation. In Maryland, we have overcome some difficulties with which our natural surround-

ings threatened to obstruct our efforts to restore Shad to their former degree of plenty. We have been able, during the season, to thoroughly test the apparatus, used to transport the shad eggs from distant fisheries to a central hatching station, to completely develop the eggs when not convenient to transfer them, and to transport the young fish after they are freed from the eggs—referred to on page 8 of my report of January, 1877. We perfected this apparatus, in its detailed arrangements, and so successful was its use during our operations at the head of the bay last spring, that we deem it worthy a more minute description, which will be found, in the account of the Shad hatching work, on another page.

The more important apparatus, of which the above was auxiliary, is that used at the central station, capable of perfecting an almost unlimited number of eggs safely, without danger from storm, independent of current, and at comparatively small cost. This apparatus, original in design and novel in construction, is fully described in the drawings and specifications of the patent granted by the United States Patent Office; these are reproduced in the account of Shad-hatching operations.

For the third apparatus, which marks the advance in fish culture in Maryland during the year, we are indebted to Mr. Thomas Winans, of Baltimore, whose thoughtful study of their habits, and observations of the Brook Trout hatched in his dwelling during the winter, resulted in his devising an apparatus in which to feed the young fish. The Trout kept and fed in this apparatus attained, at three months, a size at least double that of those of the same brood which were kept and fed in the usual nursery tanks. Mr. Winans kindly presented the Druid Hill Hatching House with a number of these vessels, with all the necessary appliances, ready for the introduction of the water. The device consists in the use of an ordinary apothecaries' filtering funnel, fitted to a frame, which keeps it in position: a rubber

tube is slipped over the neck, through which the vessel is supplied with water, which flows out through a screened aperture near the top. The current, which is caused by the passage of the water through, is so regulated in force as to keep the particles of food thrown in, suspended about midway, constantly in sight of the fish, and easily attainable by them. The food is consumed without being deposited on the bottom, as in the ordinary nursery tanks, where it remains, uneaten by the fish, and, unless carefully removed, to putrify and vitiate the water. By the use of these glass-funnels, the movements of the fish are plainly visible, and the exhibition of those reserved for experiment and illustration, made attractive. Such was the success from the use of these glass-funnels, that we are about to introduce them on a considerable scale in the Hatching House. Those presented by Mr. Winans are about the maximum size that can be constructed of glass. But as the fish increase in size, we will use the inverted cones, such as illustrated in the account of the Shad hatching operations. These, though having the advantage in cheapness and capacity for greater size, are, of course, opaque, and not so attractive. Although vessels of the inverted cone form had been used for four years by us, for the purposes of propagating fish, to Mr. Winans is due the credit of first placing this form of vessel to the use of rearing as above described.

The evidences of the success of the work in other States, and the indications of the success, which can be confidently looked for in time, in our own State, have taught us that we are not pursuing a vain or idle fancy; that the energy which has inspired most of those who have entered upon the prosecution of this comparatively new industry, is not the energy of wild enthusiasts, but the vigorous action which truth inspires, and the consciousness of the good which will result to the country, and the benefit to mankind by a greater production of healthy and cheap food.

We, have not only learned that we are doing the right thing, with reasonable hope for success, but, by the advance made in the methods and apparatus above referred to, have found how best to do it; but almost as important as these, is the increased interest which the people take in the work of the Commission. The gathering of spawn at points easily accessible to the people; the development of the ova in so public a place as Druid Hill Hatching House, where every one is cordially admitted, so that every stage of that development can be seen, and the gradual changes watched; the distribution of the young fish; the successful conduct of Shad hatching at the head of the bay, where all so disposed could see, and the constant reports which the press of the State have given, have tended to cause the people to think earnestly, and give the subject more thoughtful consideration than heretofore. The consequence is, that fish are no longer looked upon as spontaneous and inexhaustable products of the waters, and it is no longer deemed the first duty of every one to take and kill every fish seen, whether needed for food or not. With this more just appreciation of the origin, and the natural laws which govern the growth and existence of fish, comes the desire for their protection, that they may be tributary to our comfort, and a never failing means to our support. Thus, hand in hand with fish culture, should come intelligent and systematic protection, so necessary for its success.

The full results can never be derived from the artificial propagation of our food fishes, unless aided by legislative protection; but no protective laws rigidly enforced, short of a total suspension of fishing, unaided by artificial propagation, can restore our Shad and Herring fisheries to their former glory. The Shad and Herring are taken together, except in the gill nets, and they commence to spawn, the Herring first some two weeks after they appear, and the spawning season extends through the spring. It is, therefore, impossible to protect them in their spawning time, ex-

cept by not taking them at all; for their capture is not possible at any other time. After an individual Shad or Herring is taken, that's an end of it; there is no way of saving him or her, even if found ready to reproduce, let the captor be ever so disposed to do it. But the Shad and Herring are enormously prolific, the Herring more so than the Shad; or rather they each have great capacity for reproduction; but that the results from the natural production of those fish which escape, are at all approximate to the number of eggs contained in the ovaries is very doubtful. I am inclined to think that by far the greatest loss, with this class of fish, is during the egg state. It is impossible to make any estimate as to the percentage of loss of eggs from unimpregnation, destruction by sediment, and by being preyed upon by Eels and other fish, but it must be very large. In very many cases where nature is most lavish as to numbers, does she permit the greatest waste, and with many of the fishes, we can observe that the natural protections given the eggs are inversely as the number produced by the parent. The male of some of the *Siluroids carry the half doz. or so eggs deposited by its mate in the mouth, and care for them until developed; whereas the thousands produced by the Shad are left to be preyed upon by every passing fish. The Salmon yield much fewer eggs than the Shad, and they are apparently much more carefully deposited by the fish, and with much better chances of becoming impregnated by contact with the milt than the Shad eggs, yet Mr. Myron Green, foreman of the United States Commission Hatching Station on the McCloud river, found that not more than eight per cent. of the eggs naturally spawned were fertile. See report of Commissioners Fisheries California, 1877, page 12, for this statement: "After throwing out all the eggs found not to be fecund, there were left eight per cent. of the whole number gathered, which were found to be fertile. When eggs and milt are artificially brought in contact out of the water, it

*Arius fissus, A. Boakii.

would be carelessness or inexperience that would prevent ninety-five per cent. of the eggs from being fertilized."

The great loss of eggs from causes above referred to, makes it necessary that a very large number of breeding fish should be left to spawn, so as to provide for the yearly consumption.

As the eggs which are hatched artificially are taken from the fish after they are practically dead and *en route* to market, the young fish derived from this source are a clear gain, and must ever be an important addition to whatever numbers may be produced by stringent protection.

HATCHING HOUSE.

During the year, the Hatching House has been much improved and the interior repainted; the filtering tank in the house has been much enlarged, so that the Spring water can be more slowly and thoroughly cleansed of sediment, and separate filtering tanks have been constructed on an adjacent hill, in which the water derived from the city reservoir is filtered before being introduced into the building. The elevated position of these filtering tanks has enabled us to carry the water into the second story; the two rooms formerly occupied by the attendant have been thrown into one, and will be used hereafter as a nursery and hatching room, adding very materially to the capacity of the house. The regular routine work connected with the care of spawn of the fall and winter spawners, and the distribution of the young fish when sufficiently advanced, was conducted during the winter of '76 and fall of '77, with the usual success. On the 1st of May, I found it necessary to transfer the force of trained men to the Shad-hatching station, and work in this department ceased until fall, when active operations commenced with the receipt of 200,000 eggs of the California Salmon.

The details of the distribution of fish from the eggs received in the fall of '76, and not included in the last

report, that is, from January 1st to June 4th, amounted to 31,000, as will appear from the tables hereafter given. These, with the distribution made in the fall of 1876, amounting to 784,640 (see pages 22 and 23 of report of '77,) make an aggregate of 815,640 from the eggs received in the fall of '76.

On the 10th day of October last, I received, through the kindness of the United States Commissioner, a crate of Salmon eggs, containing about 200,000; on unpacking, only 6,689 dead eggs were found, a very small loss during the transfer across the continent. The distribution made of the young fish hatched from this lot will appear in subsequent table. There are still at the Hatching House, about 10,000 young fish, which have been kept for future distribution and experiment.

The loss of young fish from this lot of eggs was unusually large. The weather was unusually warm when the eggs were laid down, and the water being unusually warm, the fish were perhaps prematurely hatched.

There are now in the hatching apparatus about 180,000 eggs of this fish, also a contribution from Professor Baird, and when hatching and ready for distribution, will be disposed of as usual. These are eggs which were received in two lots by express from California—one of 100,000 on December 5th, only 1,430 having died en route: the other lot of 80,000 reached the Hatching House on the 13th. They were taken, as I understand, from younger fish, which spawn later in the season, and after the regular operations of the United States Commission on the McCloud river had ceased; the eggs arrived in good condition, and are considerably larger than any eggs of the California Salmon yet received. Of the 2d lot of 80,000, only 2,595 were found to be dead when they were unpacked.

The total number of California Salmon planted during the two years ('76 and '77,) 911,040, recorded in last report, and

150,500, as will be seen from table, is 1,061,540; if to these are added 170,000 for the produce of eggs now in the Hatching House, as these will be distributed during the Winter, we have an aggregate of 1,131,540 California Salmon planted from the eggs of 1876 and 1877, and since the commencement of this work by the Maryland Commission, an aggregate of 1,644,304 hatched and planted.

During the year, the *avant courier* of those first deposited should appear in the bay and tributary rivers; but we cannot look for the appearance of any large number, even if the experiment of their introduction is thoroughly successful, before next year, or possibly the year after.

We have made the effort to stock the Maryland waters with this variety of Salmon on the very large scale shown, as we are inclined to believe that their introduction will prove successful, notwithstanding the fact that the Salmon family has been considered an inhabitant of extreme cold waters only. We selected the California variety, not only as of more rapid growth than the Eastern, (*salmo salar*,) but also from the fact that they frequented much warmer waters than their Atlantic cousins were ever known to inhabit.

The following information given by the California Commissioners is of great importance, and answers the oft repeated question: Will the Salmon be able to live in our warm waters?

"The statistics hereafter given of the temperature of the water through which the Sacramento and San Joaquin Salmon pass to reach their spawning grounds, show that they swim for hundreds of miles through the second hottest valley in the United States, during the hottest portion of the year, where the mean temperature of the air is 92° Farenheit, and of the water, 75°. These statistics have been obtained from the record kept by the Central Pacific Railroad Company, and are for the months of August and September of the years 1875, 1876 and 1877. They are of importance as showing that the Sacramento Salmon will enter

rivers for spawning purposes, where the water is so warm that the Eastern Salmon (*salmo salar*), if it were to meet it, would turn back to the ocean. They are also of importance as illustrating the probability that there are many streams on the Atlantic coast, from the Potomac to the Rio Grande, into which this fish could be successfully introduced."

That the Eastern Salmon can be acclimated, at least in the Susquehanna and Potomac, seems now to be possible. We have, from time to time, placed a few thousands of the Penobscot Salmon in the tributaries of these rivers, by way of experiment, and as they have been so successfully introduced in the Delaware, may be rewarded by like results in the tributaries of the Chesapeake.

There has, to some extent, existed a very erroneous opinion as to the value of the Salmon as a food fish, an impression, no doubt, caused by the glowing descriptions of the exciting contest with this king of fishes, given by enthusiastic anglers since the days of Isaac Walton. Their introduction into Maryland has met favor rather with the angler than the fisherman. But that the Salmon occupies a prominent place among the fishes which furnish largely a healthy food for mankind, and add materially to the wealth of any country producing them, is shown by the following statistics of the yield of two rivers alone

"The following tables will show the numbers and weight of Salmon transported on the railroads and steamboats from the Sacramento and San Joaquin rivers to the cities of San Francisco and Stockton, from points on the river below the cities of Sacramento and Stockton, from November 1st, 1875, to August 1st, 1876, and from November 1st, 1876, to August 1st, 1877. They do not include the catch of the fisheries at Tehama or near the mouth of the Feather river, nor do they include the fish taken on the upper waters of the Sacramento and San Joaquin, nor the Salmon brought to market by fishermen in their own boats; therefore, to the totals should be added at least twenty-five per cent., to show an approximation of the actual catch:"

STATEMENT

"Of Salmon transported from the following stations on the Sacramento and San Joaquin rivers to San Francisco and Sacramento, from November 1st, 1875, to August 1st, 1876

FROM THE FOLLOWING STATIONS TO SAN FRANCISCO:

Collinsville, New York of Pacific, Rio Vista, Emmaton, Jersey Landing, Antioch, Benicia, Clarksburgh, Courtland, Martinez, Kentucky, Bradford, Sacramento, Vallejo, and Webbs.

127,843 loose Salmon, weighing	3,196,075 lbs.
2,433 boxes of Salmon, weighing	486,030 lbs.
3,118 sacks and baskets of Salmon, weighing	311,800 lbs.
158 barrels of cured Salmon, weighing	31,600 lbs.
512 barrels and boxes of smoked and dried Salmon, weighing	102,644 lbs.
Total	4,128,149 lbs.

FROM THE FOLLOWING STATIONS TO SACRAMENTO:

Courtland, Benecia, Rio Vista, Collinsville, Emmaton, and Clarksburgh.

1,116 loose Salmon, weighing	29,150 lbs.
106 baskets and sacks of Salmon, weighing	10,600 lbs.
53 barrels of Salmon, weighing	12,850 lbs.
414 boxes of Salmon, weighing	57,440 lbs.

FROM ANTIOCH TO STOCKTON.

70 loose Salmon, weighing	1,750 lbs.
46 boxes of Salmon, weighing	9,200 lbs.
Total weight of Salmon	4,249,139 lbs.

NUMBER OF STURGEON.

5,466 loose Sturgeon	274,375 lbs.

STATEMENT

Of Salmon transported from the following stations on the Sacramento and San Joaquin rivers to San Francisco and Sacramento, from November 1st, 1876, to August 1st, 1877.

FROM THE FOLLOWING STATIONS TO SAN FRANCISCO:

Collinsville, New York of Pacific, Rio Vista, Emmaton, Jersey Landing, Antioch, Benicia, Clarksburgh, Courtland, Martinez, Kentucky, Bradford, Sacramento, Vallejo, and Webbs.

143,998 loose Salmon, weighing	3,599,950 lbs.
1,903 boxes of Salmon, weighing	384,300 lbs.
3,454 sacks and baskets of Salmon, weighing	345,400 lbs
128 barrels of cured Salmon, weighing	25,600 lbs·
653 barrels and boxes of smoked and dried Salmon, weighing	132,788 lbs.
8,542 boxes canned Salmon, weighing	546,688 lbs.
Total	5,034,726 lbs.

FROM THE FOLLOWING STATIONS TO SACRAMENTO:

Courtland, Benicia, Rio Vista, Collinsville, Emmaton, and Clarksburgh.

1,511 loose Salmon, weighing	37,775 lbs.
208 baskets of Salmon, weighing	20,800 lbs.
414 boxes of Salmon, weighing	74,350 lbs.
47 barrels of Salmon, weighing	11,950 lbs.

FROM ANTIOCH TO STOCKTON.

106 loose Salmon, weighing	2,650 lbs.
63 boxes of Salmon, weighing	12,600 lbs.
Total weight of Salmon	5,194,851 lbs.

NUMBER OF STURGEON.

5,913 loose Sturgeon, weighing	295,650 lbs."

"In our last report, after adding twenty-five per cent. to the statements of the catch which we obtained, we showed the total weight as transported from the same places, from November 1st, 1874, to August 1st, 1875, to be five million ninety eight thousand seven hundred and eighty-one pounds. Adding the same percentage to the totals in the above tables, and they show the catch from November 1st, 1875, to August 1st, 1876, to be five million three hundred and eleven thousand four hundred and twenty-three pounds;

and from November 1st, 1876, to August 1st, 1877, six million four hundred and ninety-three thousand five hundred and sixty-three pounds.

This shows a gain of more than a million of pounds in the legal catch over any year since the organization of the Commission, and may be ascribed to the fact that our waters are now beginning to feel the beneficial effects of the millions of Salmon hatched artificially and turned into the headwaters. We have no means of ascertaining the weight of fish taken out of season, but estimate that between August 1st and November 1st of this year, not less than two million pounds were taken in defiance of law."

Thus, it will be seen that the Salmon fisheries of California are of hardly less importance than our Shad and Herring fisheries.

The distribution of Brook Trout, in pursuance of the programme given in report of January, 1877, will be found in tabular form. In addition to these, about 10 000 Lake Herring and about 15,000 White Fish hatched from eggs gathered by Wm. H Hines from Lake Erie for the Commission, were placed in the big pool on the Chesapeake and Ohio Canal.

We have secured 350,000 Brook Trout eggs, a large portion of which have been hatched and will be ready for distribution about the middle of January, and notice to this effect has been very generally published throughout the State.

It is gratifying to be able to state that the total cost of these fish will be about $2.55 per thousand. With the want of facilities for the storage of breeding fish, and the undeveloped resourses of the Commission, this compares very favorably with the estimated cost (15 s. per thousand,) of the production of Trout at the celebrated establishment at Huningen, under the careful and economic management of Mr. Haack.

SMELT-HATCHING OPERATIONS.

The efforts to propagate artificially the Smelt, *Osmerus mordax*, of the Raritan river, New Jersey, in 1876, when we procured the adult fish which were about to spawn, as they were taken from the river in the nets fished at New Brunswick, and transferred the fish to the Hatching House in Druid Hill Park, there took the eggs and milt from them, and treated the same in the apparatus there in use, having resulted unsuccessfully, I determined to repeat the experiment, establishing headquarters at New Brunswick, and taking the eggs from the ripe fish as they were landed from the seines.

Having visited New Brunswick with this view, and made the necessary arrangements, I transferred the apparatus and improvised a temporary Hatching House. On the 3d of March, having secured the services of Mr. H. J. Rice, Fellow in Natural History of the Johns Hopkins University, through the kindness of President Gilman, the able head of the University, I placed under his direction Wm. Hamlen, one of the employees of the Commission, who had been carefully trained by me in taking the spawn of several other varieties of fish.

The record of the operations at New Brunswick will be found in subsequent table; the detailed account of the operations, and history of the gradual development of the eggs, will be found in Mr. Rice's able report appended, which is illustrated by accurate and well executed microscopic drawings made during his sojourn at New Brunswick. As Mr. Rice gives a full and interesting account of operations and natural history observations, I think it unnecessary to go into more full details.

On the 20th of April I reached Baltimore with several cans of young Smelt—the result of these experimental operations. It was impossible to count them, or to estimate with any certainty the number of fish contained in these cans, as

they were very much smaller than any we had been accustomed to handle; but I got several parties, who had been in the habit of carrying Shad, to estimate them, and the estimates ranged from a half to three-quarters of a million. To be within bounds, I have recorded them 400,000—the number of young Smelt planted in the waters of Maryland. About one-half of these were deposited in the head-waters of the Severn, on the 21st April. About two-thirds of the remaining 200,000 were placed in the head-waters of the Wye. The others were left in charge of Hon. Edw. Lloyd, Senator from Talbot, who kindly transferred them to the head-waters of the Saint Michael.

In addition to these young fish, some few adults were deposited in the Wicomico river at Salisbury, under the direction of the Hon. Thomas Humphries, who represents Wicomico county in the Senate.

If the Smelt can be successfully introduced into the waters of the Chesapeake bay, they will be a very valuable acquisition; and that they can easily be influenced by artificial means has been shown in Massachusetts. (See extract of letter from Hon. Theodore Lyman on page 2.)

These fish being very small, and liable to be preyed upon by the larger fishes inhabiting the bay and the neighboring ocean, it is necessary that they appear in very great numbers for their presence to be felt.

By reference to Mr. Rice's report, page 48, it will be seen that they are a very prolific fish, and once established, the supply can be readily kept up.

SHAD-HATCHING.

Having been unable to secure ripe fish in sufficient quantities at any one point on the smaller rivers of the State, the Shad having become scarce in these streams, I determined to concentrate operations at some central point where a great many large fisheries could be visited, and the fish

taken by them, overhauled. The experiences of the spring of '76 convinced me that a much larger number of ripe fish, and consequently a much larger number of eggs, could be procured in this manner. I therefore communicated with the Commissioners of Fisheries for Virginia, and proposed that they should join with me in the work on the Potomac; this, however, they declined to do, from want of funds. The appropriation at my command was not sufficient for me to equip two central hatching stations, and I was, therefore, compelled to postpone operations on the Potomac. I deemed it more advisable to concentrate the work at the Head of the Bay, a more central locality: and a much larger number of citizens of the State would be benefited by the return of the fish deposited in waters over which the State had entire control, and on which bordered all the tide-water counties, except Prince George, Charles and Worcester.

The interest which Prince George, Charles and St. Mary's counties have in the fish of the Potomac is so large, and the yield of the fisheries of this river is so important to the State, that the most strenuous efforts should be made to restore them.

It is hoped that the General Assemblies of the two States will make the necessary provisions for their restoration before the next fishing season, and that the States will join in the work of artificial propagation and mutual protection, the beneficial results of which will be shared by their citizens in common.

Several hundred thousand of young Shad were transferred by rail from the station at the head of the bay and deposited in the Potomac, as will be seen by table of distribution.

Hereafter, with the success which must follow our increased facilities and experiences, very much larger numbers can be thus transferred from the bay to this important river, even if we are not provided with means to bear the whole expense of a separate station, or in the event that the Virginia Commissioners do not co-operate with us.

Having decided, therefore, to concentrate all our energies and means at the head of the bay, in the neighborhood of Havre de Grace, I watched the condition of the water and the season closely. The weather kept unusally cold during April, and the development of the ova in the ovaries was very much retarded; it was not until the 25th of April that I found, on visiting the battery of Capt. Cole, which was located just above the railroad bridge, at the lower end of Watson's Island, some Shad, with spawn considerably advanced, and the milt ripe in the male fish.

I found, on this occasion, quite a number of ripe Herring, and took some two or three hundred thousand eggs, which I placed in the hatching apparatus on the steamer; but being compelled to return to Baltimore to complete the equipment for the Shad-hatching, the eggs could not be left in the hatching apparatus until matured; the experiment made with them, however, although unsuccessful, was important as the first step towards the work of the future.

On the 30th of April, having secured from the Harbor Board of Baltimore the use of three large deck scows, and having erected machinery and apparatus, hereafter described, I had them towed to the head of Spesutie Island, and a few days subsequently to Havre de Grace.

Havre de Grace was chosen at this time, not only as being a very central location, but as a point from which we could get the remaining material needed for the completion of the works on the scows. It was not until the 8th of May that any ripe spawn was found. At this date, in the neighborhood of Havre de Grace, there were in operation four batteries and one shore fishery above the railroad bridge; below the bridge, on the Susquehanna flats, three more batteries; on the western side of the bay, the Old Bay Fishery and a small fishery at the mouth of Swan creek, and the upper and lower fisheries on Spesutie Island.

On the eastern side of the bay, the Cecil county side, the large fisheries of Fletcher Wilson, Wm. Wilson, Caruthers

& England, Russell, and two at Carpenter's Point, owned by Mr. Washington Barnes.

The total length of the seines of these eighteen fisheries is about 26,350 yards, and the ripe fish caught by this immense aggregation of seine can all be utilised for furnishing spawn for a central hatching station, by means of proper organization and equipment.

All of these fisheries were visited from time to time. It will be seen, by reference to the table showing the temperature and the details of the operations conducted, that the air and water continued quite cold, for this season, until about the 12th of May, when there was a constant southerly wind and increase in the temperature; on the night of the 14th, having gotten the apparatus in working order, I visited, for the first time, the fisheries on Spesutie Island and the eastern shore of the bay. On this one night I took, at the smallest calculation, 1,250,000 eggs. These were kept, during the night, in the tanks on the steamer, and the next morning taken to Havre de Grace.

The yield of spawn was so much greater from the fisheries on the Cecil side, that I determined to move the apparatus to Carrot cove, on the North East river; consequently, on the next day, I had the scows moved round to this more convenient locality, and this continued to be our central station until the 27th, when I deemed it advisable to move the scows to Spesutie narrows.

The water at the mouth of the North East and in Carrot cove, being shallow, was more easily influenced by the temperature than the deeper and more rapidly flowing water at Spesutie narrows. About this time, the weather became exceedingly hot, and the temperature rose rapidly to 78°. Spesutie narrows was also a more central station for the gill-nets, and as the season was about closing for the seine-haulers, we had to look for our supply of ripe fish to the gill-nets alone.

From this station, on the 1st of June, I commenced the distribution of fish, by means of the steamer, to the several important rivers of the Eastern Shore. On the 1st of June, I deposited 126,000 in the Bohemia, near the bridge across that stream; on the same day, 150,000 in the Elk, and 285,000 in the Sassafras. I am indebted to Hon. Wm. M. Knight for assistance and guidance in this transfer, as he accompanied me on the trip from the Bohemia to the Sassafras. On my return to the hatching station, I took a large number to the Choptank river, which was reached on the morning of the 5th; the fish in good condition. After stopping a few hours at Cambridge, for the purpose of securing a pilot, I proceeded up the river, and deposited 510,000 young fish in the Choptank, just below the town of Denton.

On the 11th of June, having secured from the hatching station 300,000 more fish, I proceeded down the bay to Crisfield, which place I reached on the morning of the 12th, in time to ship them by the mid-day freight train to Salisbury. Those intended for the Wicomico, 100,000 in number, were placed in that river at Salisbury, under the supervision of the Hon. Thos. Humphreys, Senator from Wicomico; 100,000 were also shipped to the Pocomoke, and deposited in that stream at the point at which the Wicomico and Pocomoke Railroad crosses the stream, and 100,000 were placed in the Nanticoke at Seaford.

Prof. Baird, at my request, undertook the distribution of the fish by rail to those localities which could not be reached by the steamer. Accordingly, he caused to be transferred to the Potomac 250,000; of these, 150,000 were deposited at Piedmont and the rest below Washington; 100,000 were put in the Patuxent river, where the railroad crosses it, and 50,000 in the Gunpowder river, near Cockeysville. This completed the distribution of Shad in Maryland waters, making in all 7,419,300.

An interesting account of the operations at the head of the bay, and the development of the ova of the Shad, will

be found in Mr. Rice's report to me of his observations upon the development of the Shad, on page 95, *et seq.*

The Frontispiece of this report is a representation of the apparatus referred to on page 7, which was erected on the steamer Lookout.

This apparatus consists of tank "B," which is placed on a tank "C," to give it an elevation sufficient to supply the several inverted cones "A," with a constant circulation of water; this is supplied by means of a steam pump, located below the deck and provided with steam from the boiler, which also supplies the main engine. The water is drawn direct from overboard through the sea-cock, and is conducted from tank "B" through filters "a," and rubber tubes attached, to the *apices* of the inverted cones, and overflows at "f." The waste water is conducted through pipes "e" into waste-tank "D," and thence carried overboard through pipe "E." The distributing-tank "B" is provided with a tube "g," which serves a double purpose—an outlet for the air, and, when necessary, an overflow for the surplus water. When it is necessary to furnish a stronger flow by direct action of the pump, the rubber tubes can be transferred from the filters "a" to pipes "d," and the valve at "b" shut off, so as to force the water directly into the inverted cones. The pump is furnished with two suction orifices, and when running in salt water, the outlet "E" is so arranged that by turning it into the hatch shown in the drawing, and attaching it to the suction pump, the water, after having passed through the hatching cones "A," is repumped into tank "B," and a circulation of the same water kept up.

The large tank "C," which is used for a support to tank B, is also supplied with fresh water, to replace any waste from splashing, evaporation, &c. It will be seen that by means of this apparatus, hatching operations can be conducted on board the steamer, whether in motion or lying at anchor, either in fresh water, when the supply is taken from overboard, or in salt water, when the circulation and renewal

of the water is kept up by the arrangement referred to. The thorough efficiency of this apparatus was demonstrated last spring, as in the five tanks shown in the drawing, over a million of eggs were easily kept during twelve or fifteen hours, until the central hatching apparatus was reached; and, in some cases, several hundred thousand eggs were kept in these tanks from the time they were taken until completely developed and the fish distributed.

These vessels were also very efficient for transferring the young fish from one portion of the State to another. In this constant circulation of the water, the fish can be transferred much better than in the ordinary transfer cans, such as shown in the illustration. The other form of apparatus which was used at the central station, is fully described in the specifications of the patent, as follows:

THOMAS BARKER FERGUSON'S

IMPROVED FISH HATCHING APPARATUS.

This invention relates to methods and devices for hatching spawn of fishes, and has for its object, to hatch such spawn in still waters where the current will not impart sufficient motion to the eggs, or furnish them with a sufficient change of water; and also in waters exposed to storms. To this end, the nature of the invention consists in a series of vessels in which the spawn is placed, combined with a mechanism that will impart sufficient motion to the vessels to create the necessary current and change of water. It also consists in the construction of the spawn vessels, and in the construction and combination of parts, as will be hereinafter more fully set forth.

The annexed drawings, to which reference is made, fully illustrate my invention. *A A* represent a series of cylindrical vessels made of sheet metal or other suitable material, and of any suitable dimensions, and which may be made slightly tapering, or not, as may be deemed most advantageous

Each vessel *A* is provided at its lower end with a bottom *B* of wire cloth or similar material, which is held in place by means of a metal band *C* as shown. Under certain circumstances, the top of the vessel may be provided with a similar wire cloth *B'*, held in place by a metal band *C'*; this latter band being placed within the vessel, while the bottom band *C* surrounds the lower end of the vessel on the outside.

By this means the wire cloths *B* and *B'* can be easily removed when required, and as easily replaced.

The vessels *A* are provided at the top with suitable handles *a a*, and are suspended by means of wires, cords or chains *b b*, from the devices hereinafter described.

E represents the hull of a boat, scow or other vessel, or pier, on each side of which is arranged a series of levers *D D*, pivoted on such boat or vessel, and their outer ends projecting a suitable distance beyond the side of the same. These levers *D* on each side of the vessel may be arranged singly or in pairs. If in the latter way, the two levers forming a pair have a rod *d* passing through their outer ends, and a series of vessels *A* are suspended from said rod by means of the cords or chains *b*.

The vessels *A* thus hang outside of the boat or vessel in the water in such a manner that, when the lowest, they will only be about two-thirds under water. The inner ends of the corresponding levers on the two sides of the boat may be connected together as shown, or in any other suitable manner, or they may be left entirely disconnected if so desired. These levers are operated by a series of eccentrics *I I*, set at varying angles upon a continuously rotating shaft *G*, connected to, and rotating by a steam engine, or other suitable motive power.

The levers *D* may be mounted above the deck of the vessel, or they may be arranged below the deck, and project through the sides of the vessel; and the shaft, with the eccentrics, arranged to correspond with the location of the levers. In either case, these eccentrics should be of such form that a slow motion upward would be secured for the vessels *A*, while they should move more rapid, though gradually, downward.

By this means a current is created, even in still waters, sufficient to keep the eggs placed in the vessels *A* in motion, and change the water through the wire cloths in the bottoms of the vessels.

When the boat or vessel is placed in water having a sufficient current, no movement of the levers *D* is necessary; and in such case, each vessel *A* is held in an inclined position by means of a side chain or rope *e*, so as to allow the current to pass through the vessel. In such case, as well as in storms the tops *B* should be put on the vessels *A* to protect the spawn.

The vessels *A* being cylindrical in form, present no angles or corners in which sediment, dirt or matter deleterious to the life and development of the spawn can collect, and they are easily kept clean. Being made of sheet metal or other metallic substance, it prevents the development of injurious fungi and conferva. Another advantage of the cylindrical form of the vessels is, that it requires less force in its movement in the water than a box having angles or corners.

By this invention, the spawn of fishes may be hatched in still waters, currents, and waters exposed to storms.

Having thus described my invention, what I claim as new, and desire to secure by letters-patent, is—

1st. In the hatching of fish spawn: the method of producing change of water in the vessels containing the spawn, and currents for moving the

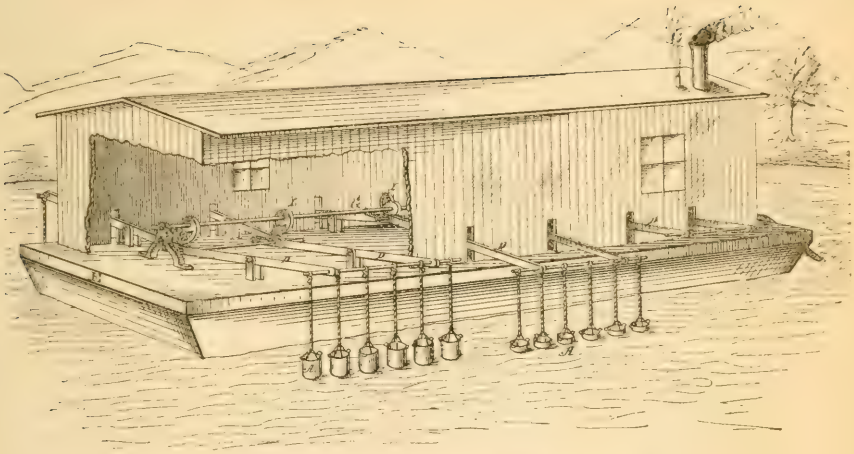


Fig. 2.

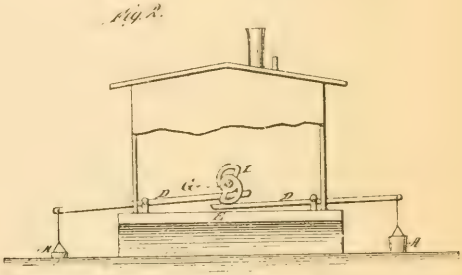


Fig. 3.

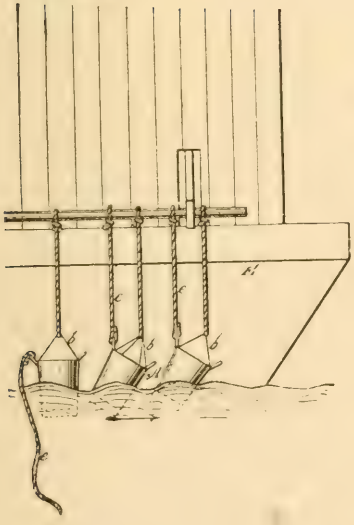
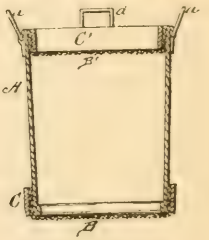


Fig. 4.



eggs, which consists in reciprocating the boxes or vessels in the water, substantially as herein set forth.

2d. One or more series of vessels for containing spawn, in combination with a mechanism for moving the same up and down in the water, substantially as and for the purposes herein set forth.

3d. The combination of the cylindrical vessel *A*, wire cloths *B B'*, and fastening bands *C C'*, substantially as, and for the purposes herein set forth.

4th. As a means for the hatching of fish spawn, the combination of a portable scow or other vessel with a series of vessels *A*, suspended from pivoted levers *D*, which are operated by a series of eccentrics *I*, set at varying angles on a continuously rotating shaft *G*, substantially as set forth.

The period in which Shad-hatching operations can be successfully carried on in Maryland waters, is limited by the conditions and temperature of the water, to about six weeks, extending from the last week in April, the time when the first ripe fish are found, until the 10th of June, when the catching of Shad is prohibited by law, and fishing ceases. The necessity for extending the period in which the gathering of spawn, and the development of the same, can be conducted, caused me to investigate the state and conditions of the fisheries further south, believing that by taking advantage of the earlier run of fish into the rivers more southern than those flowing into the Chesapeake bay, active operations in the field could be commenced some five or six weeks earlier, and a very much larger number of young fish procured for stocking the streams of the State.

With this view, I communicated with the Commissioners of North Carolina and Virginia, and they expressed their willingness and desire to co-operate in the work at points within their States. Having been informed by Dr. Wm. R. Capehart, the owner and operator of two extensive fisheries on the Albemarle sound, that spawning fish could be had in large numbers in the neighborhood of his fisheries during the fishing season, which commences about the 1st of March —as Dr. Capehart's intelligent observations could be relied on—I deemed it of sufficient importance to the future of our

fisheries to make as thorough examination of Albemarle sound and its tributaries, as possible to be made during the winter months, when no fishing operations are conducted.

Accordingly, by appointment, I met Col. L. L. Polk, Commissioner of Agriculture, also having charge of the Department of Fish Culture of North Carolina, and Dr. Wm. R. Capehart, and together we visited the several fisheries on the sound, as well as those on the Chowan and Roanoke rivers. On investigation, we found the most favorable circumstance surrounding these great fisheries; the accompanying map will show the location of the fisheries, and the lengths of seines used.

Almost all of the fisheries laid down on the map are operated by the owners of the adjacent farms, who are men of intelligence and culture, of enlarged and liberal views, and we are assured of the hearty co-operation of the entire community of fishermen.

The Albemarle sound, 65 miles in length, and from 5 to 15 miles in width, receives from its tributaries, the Roanoke and Chowan rivers, the entire water-shed of the northern and eastern portion of North Carolina, and the southern portion of Virginia, east of the divide in Montgomery, Floyd and Carroll counties, besides the contributions of fresh water from the shorter eastern rivers of North Carolina, flowing through Bertie, Perquimans, Pasquotank, Carroll, Tyroll and Washington counties.

This immense supply of fresh water is spread out over the comparatively shallow sound, which affords admirable spawning beds for Shad, Herring and Rock. The brackish water does not find its way, even in the dryer months of summer, higher than the mouth of the Pasquotank, for the communication with the salt water of the ocean is limited to Oregon, New, Loggerhead, Hatteras and Ocracoke inlets, all narrow and comparatively shallow.

The salt water entering these inlets to replace the fresh water discharged from the sound, must pass through the

channel between Roanoke island and the main land, which is about 2¾ miles across, with an average depth of about nine feet. During the spring months, the period of the run of Shad, Herring and Rock in seeking their spawning beds, the Albemarle sound is entirely fresh, and offers to them the most suitable localities for spawning.

It will be seen by reference to the accompanying map, that most of the large seines which yield even in the depleted condition of the fisheries 500,000 Shad and 45,000,000 Herring, and 300,000 lbs. of Rock (*Roccus lineatus*), are located within 16 miles of the mouth of the Chowan river.

I have pointed out to Prof. Spencer F. Baird, U. S. Commissioner of Fisheries, the great advantages offered by this locality for procuring young Shad for distribution throughout the United States; and it is now proposed that a joint work should be conducted by the U. S. Commissioner, and the Commissioners of North Carolina, Virginia and Maryland, at this point.

Should our arrangements be perfected, I am confident that immense numbers of Shad can be procured for deposit in the streams of Maryland, before the hatching operations can commence within our own limits. They can be transported with little cost by means of the steamer "Lookout," through the Albemarle and Chesapeake canal and the lower bay to Crisfield; thence by rail to the rivers of the Eastern Shore. By thoroughly stocking these rivers with this earlier supply of young fish, it would leave the results of our operations later in the season, for deposit in the Potomac, in the Susquehanna, in the Gunpowder, in the Patuxent, and in the other rivers of the north-western portion of the State.

As the Albemarle sound has long been celebrated for the immense number and size of its Rock fish, I hope and believe that we will there be able to find ripe Rock. I have anxiously searched for spawning Rock during the four years that I have conducted the Shad culture in Maryland.

I beg leave here to express my appreciatian of the kindness shown by Dr. Capehart, and the intelligent and public spirited owners of the fisheries of Albemarle sound, and also to Col. Marshall Parks, the President of the Albemarle and Chesapeake canal, who generously tendered me the use of the canal free of tolls.

BLACK BASS.

The general prejudice which has prevailed against the introduction of the Black Bass into our Shad and Herring rivers, has deterred me from stocking such rivers with this fish, although I do not join in this prejudice; but on the contrary, believe they would be valuable acquisitions, especially to the dark water rivers of the Eastern Shore, which have not mountain sources, and for this reason are not suitable for the more valuable Salmon.

While this prejudice against the Bass has prevented a general distribution of them to the Shad rivers, the want of means has prevented a distribution to private ponds, as the appropriation has not been sufficient to warrant work, except for the restoration of the public waters, where the greatest amount possible could be accomplished for the general good.

The very numerous applications which have been received, especially from those persons having large ponds in the comparatively flat regions of the State, have caused me to make arrangements for a large supply of both the small-mouth Bass, (*Micropterus salmoides*), and the large-mouth variety, (*M. nigricans*), which I hope to distribute before their spawning season in the spring.

The small-mouth Bass is better adapted to the clearer, colder and more rapid flowing waters, and the large-mouth Bass for ponds and tidal rivers; the latter is perhaps the most valuable, as being of more rapid growth, and attaining a greater size.

A gratuitous distribution of Bass, as that proposed of Brook Trout, will supply those localities which are not suited for the Trout.

CARP.

Three importations of European Carp, made under the auspices of Prof. Baird, U. S. Commissioner, have hitherto been reported. Those brought out by Dr. Hessel, though of the best variety, were in insufficient numbers ; and those brought over by Mr. Welsher having proved to be an inferior variety of Carp, Prof. Baird determined to attempt another importation, and Dr. Hessel accordingly returned to Europe, and in May last reached New York with his cargo, and from thence brought the fish to Baltimore, arriving on the night of 26th of May, with 79 King Tench, (*Cyprinus tinca*), 227 Naked Carp, (*Cyprinus nudus*), 118 Common Carp, (*Cyprinus carpio*). These, Dr. Hessel, who has had great experience in Carp raising, reports to be from the best ponds, and of the choicest varieties known in Europe.

As it is desirable to keep the different varieties separate, and as more storage room was needed in Druid Hill Park, application was made to the City Council for sufficient means to construct additional ponds. In response to this application, one thousand dollars was appropriated for this purpose; and under the supervision of the Park Commissioners, three large and well-designed ponds are now in progress of construction. When these are completed, we will have five large ponds in which to keep the breeding fish, besides the small ponds in which it is designed to mature the eggs taken artificially from the parent fish.

For the purpose of transferring the fish across the ocean, I designed and had constructed an apparatus in which it was hoped that this transfer would be successfully made. It was intended that the fish should be brought direct from Bremen to Baltimore, in one of the Baltimore steamers, as much greater space could be devoted to the reception of the apparatus on this line than on steamers entering New York, and the most liberal accommodations were offered by the agents of the North German Lloyd at this port. This apparatus was transported to Europe by the company free of

charge. It consisted of two tanks, one of these to be elevated above the tanks in which the fish were to be placed, and located under one of the skylights. This tank supplied the water to the vessels, which consisted of deep tubs swung in gimbals, so as to keep them horizontal, notwithstanding the motion of the vessel.

The water was transferred from the reservoir through rubber tubes, to which were attached a contrivance for forcing air to the bottom of the water in the fish tanks. As this was effected by the passage of the water through the tubes, it worked automatically. In this way the fish were supplied with the necessary oxygen.

The overflow was conducted into a tank similar to and of the same capacity as that above, and thence transferred by means of a force pump to the distributing tank. In this manner, a constant change and circulation of water could be kept up without annoyance to the fish, and the water easily saturated with atmosphere.

I understand that Dr. Hessel could not get sufficient accommodations on the New York steamer in which he took passage, and therefore did not use the apparatus.

The fish were a good deal bruised on the passage, and arrived in bad condition; several of them died subsequent to their arrival at Druid Hill Park. With the increased facilities for caring for the fish in separate ponds, it is hoped that in a few years, the young from these several importations will be sufficiently numerous to stock many of the ponds to which these fish will be a valuable acquisition.

Especial acknowledgment is due to the Commissioners of Public Parks, who have aided, with the means at their disposal, the work of construction of ponds, &c., when the specific appropriations have been inadequate; and to the Water Board of Baltimore, for their liberality in supplying water during the winter months, when a much larger supply than that afforded by the spring is necessary for carrying on the extensive operations which are conducted at the Hatching House.

BUFFALO FISH.

The introduction of the Buffalo Fish is the unfulfilled promise made by the Commission, but I trust that this will be accomplished during the coming spring, as I believe that this fish will be a very valuable acquisition to our fresh waters, especially for the more stagnant ponds, which will not support any of the game fishes, and those ponds too limited in capacity to supply natural food for a large number of fish.

The Buffalo Fish is readily domesticated, and can be fed on much of the refuse from a farm. In this opinion I am sustained by Dr. E. Sterling, who is a well known and competent icthyologist. Dr. Sterling writes me: "I see that you are in favor of introducing the Lake Mullet, or Buffalo Sucker, (*Catostomus aureolus*—Lesseur,) as it is commonly called, and I think you are right. It is a rapid grower, and attains here, in three or four years, the weight of 7 to 9 lbs. It domesticates as readily as the European Carp, will feed off the garbage of the kitchen, and is by far the best table fish of the two." * * * * "Some years ago a Hungarian in my father's employ planted a number of small Mullet in a narrow deep pond of four acres. The stream supplying was of a surface character, so much so that for weeks in the hot weather no water was supplied by it to the pond; yet, the fish flourished all the same. They were fed on whatever came handy from the house, grew rapidly, and became so tame as to approach at the sight of any one coming near, especially to feed them. At the end of the third season, many had become quite large, weighing over five pounds, and during the cold weather were considered delicious food." Thus, it will be seen that by the transfer of

this fish from the western waters a comparatively good food-fish can be secured for our ponds, until the Carp become numerous enough for general distribution.

LIST OF FISHES.

The investigations of the past year have enabled us to add 12 species to the 190 enumerated in reports hitherto published, making in all 202 species known to Maryland waters. No doubt, future collections will furnish yet additional specimens to our already large representation.

The descriptive list of these additional fishes, with observations on the fall advent of the Blue Fish, and their forerunner, the Ale-wife, (*B. menhaden,*) made by Mr. Otto Lugger, the energetic custodian of the Museum of the Maryland Academy of Sciences, will be found on pages 111, and following.

In the identification of these species, we are indebted to Prof. Spencer F. Baird, Prof. Theo. Gill, Prof. G. Brown Goode and Dr. T. H. Bean, of the Smithsonian Institution, and also to Prof. P. R. Uhler, President of the Maryland Academy of Sciences, for valuable assistance.

PROTECTION.

The history of the work of the Commission for the past four years, does in itself embrace the suggestions for the protection and propagation of the food-fishes in the waters of the State, which section 4, chapter 27, Laws of 1876, makes our duty to report, but as a reference to the modes of capturing, as now resorted to in our waters, may in some measure be a guide to the more effectual means of protecting our fish

from undue destruction by them, it may be well to review the means employed; they are—

1st. Angling, or the capture by the use of hook and line.

2d. Spearing, either during the day when the fish are found in shallow water, or by the use of torch lights along the shore at night.

3d. Fish baskets or fish weirs.

4th. Haul seines.

5th. Gill nets.

6th. Fyke nets.

7th. Pound nets.

8th Purse seines.

There can never be any material injury resulting from the first of these methods, as in angling, fish are taken while in pursuit of food, and as this is limited to certain times of the day or periods of the year, even if an unlimited number were engaged in capturing fish with the line, there could not be that steady drain that results from the other methods; but for the better protection of fish, especially those inhabiting the upper waters beyond the influence of tide, the breeding season of each variety should be set aside, during which they should not be captured even by angling.

Not only does their preservation and increase necessitate this protection, but as the flesh of spawning fish is unwholesome and unfit for food, the protection of health also demands it as a sanitary measure.

The 2d method, spearing, is not to any very great extent resorted to within our State, but, as it is most efficient when the fish are on their spawning beds, and more vigilant in guarding their nests than in providing for their safety, and as it is resorted to chiefly at night, when there is little probability of well regulating the use of the spear, under the supervision of the law, this method should be prohibited altogether.

These two methods of capture, are, however, simply resorted to for supplying a home consumption and local demand.

Except with some fishes which do not frequent our waters, they are rarely resorted to as a means for supplying fish for an extensive market or for export.

Fish baskets or weirs, as described in previous reports, are also used for meeting a home demand and furnishing a local supply, but as the injury they do to the streams in which they are operated, and their capacity for destruction is so much greater than the amount of good produced, their use should be prohibited by law.

The haul seine is perhaps the most ancient and extensively resorted to method for capturing fish, not only to furnish a comfort for home, but for supplying the general market.

There is a considerable amount of capital invested in haul seines and their necessary equipments, and a very large yearly yield of healthy food is derived from the seine fisheries of our State.

As there are large interests involved, and as an immense food supply is furnished for home consumption and export, by the haul seine, the advantages and disadvantages of this method should be carefully weighed, so as to avoid any unjust discrimination against, or undue license to its employment.

The haul seine, the gill net, stationary or floating, and the pound net, are each operated by separate, distinct and antagonistic interests. Each class has much to say in favor of its special mode of capture, and a very great deal against that of every other.

Those operating the haul seine, while acknowledging that they capture every thing within their "lay out," and that all the fish are destroyed that are brought to shore, yet argue, and with effect, that they are only operated periodically, and that the fish are undisturbed for several hours during the day, and an opportunity offered for many to reach their spawning beds.

The largest seines and the greatest number of men are employed during the spring, at the time of the run of Shad

and Herring, and with many of the larger ones not more than two or three hauls are made during the twenty-four hours, which gives the fish considerable opportunity to pass and reach their spawning beds.

The haul seines are not operated until the close of the spawning season, but allow the fish which have escaped, a considerable time to spawn undisturbed. Again, the young Shad and Herring are not in the water at the time that the seines are used for the capture of the adults, and they do not materially injure the young of these fish—they are, however, very injurious to the partially grown of other varieties. The lead line dragged over the bottom, almost constantly, no doubt destroys great quantities of spawn, but more especially that of other varieties than the Shad.

The gill net is very extensively used in Maryland, principally for the capture of Shad, although, of late years, Herring gill nets are becoming very generally used, both on the Potomac and upper bay.

Those operating the gill nets, argue in favor of this mode, that the meshes are so large, that none but the large marketable fish are captured, while the small fish pass through freely, and that in many localities they can only operate these nets at night and at certain stages of the tide, giving the fish good opportunity for reaching their spawning beds; however, in some localities where the water is not clear enough to enable the fish to avoid the nets during the day, they are kept in the water almost constantly, and have no doubt contributed very materially to turn back the fish, and prevent them from reaching their natural spawning beds in the upper waters.

Very many of the smaller fish of the Shad and Herring, which effect their escape from the gill nets, are taken in seines higher up the rivers I have found the spawn dead in almost all those fish that I have examined, thus showing that although they themselves may escape, they will not reproduce after being bruised by their struggle through the meshes.

The fyke net is not very extensively used in Maryland waters, but the principal objection to its use is, that it is one of that character of apparatus which can be constantly operated.

The net with its leaders, often occupying the entire width of the smaller streams, prevents the passage up or down of any fish too large to pass through its meshes. This, with the pound net and other stationary apparatus for catching fish, should only be permitted under restrictions which would cause its being taken from the water periodically during the migrations of the fish.

Those operating the pound nets claim the same advantages that the gillers do for their method, that they capture only the marketable fish, as the meshes used are too large for all but the fish of marketable size to pass through them; but these nets with their leaders being stationary and almost all the time in the water, prevent very many fish from ascending the bay and streams, and very many marketable fish which are not taken are thereby turned back and prevented from reaching proper localities in which to reproduce.

It has been found, in those rivers from which the fish have been debarred from ascending and reaching proper spawning grounds, that in a very few years they have entirely disappeared, even from the mouths of the rivers, so that the final disappearance of fish from a river is not only dependent upon the destruction of those captured, but also upon the failure of those escaping to reach their accustomed spawning beds.

As much can be said of the advantages and disadvantages of each of these methods of capture, it would appear most practicable and the wisest policy to permit the use of each kind of net, but under proper restrictions.

A periodical close time during the run of fish, and a total cessation of their capture at certain times, so as to leave them entirely undisturbed on their spawning beds, are necessary measures to arrest the alarming decrease in our fish yield.

The greatest injury, however, which is done to our waters of the Chesapeake bay and tributaries, without any compensation whatsoever to our citizens, is the capture of fish throughout the year by means of haul seines and purse nets, operated by parties who come into the bay with vessels well supplied with ice, capture the fish and take them to other markets.

Immense numbers of fish are taken by this class, citizens of other States, every year, and carried to Philadelphia and New York, and there is not the remotest, even temporary, benefit that the State derives from the depletion of her waters, as the fish are taken by non-residents who seldom have any communication with the shore, except, perhaps, to land their nets in defiance of the wishes of the proprietors of the land.

CONCLUSION.

In conclusion, I would repeat, as the result of the more close observation of the past two years, the causes to which I attribute the decrease in the fish yield of our waters, and the remedies suggested therefor, namely—

"1st. Excessive fishing.

2d. The cutting off of the migratory fishes from their spawning beds.

3d. The disturbing of the breeding fish on their spawning beds.

4th. The destruction of spawn, by washings from cultivated fields, and natural enemies.

5th. The destruction of young fish, by improper means and modes of capture.

The remedies are—

1st. Artificial propagation to supply the excessive drain caused by increased population, and improved means of capture.

2d. By prohibiting all fishing with nets, seines or fixed apparatus for thirty-six hours in each week, during the migrations of anadromus fishes, so as to give a sufficient

number of breeding fish an opportunity of reaching their spawning grounds, (this is universally believed to be the most important step towards the preservation of our best food fishes.)

3d. By protecting the fish on their spawning beds; that is, by prohibiting their capture as their spawning seasons approach, (the habits of each species must determine the period in which it should be protected.)

4th. By the apparatus of fish culture to protect the eggs and young fish from the causes of loss.

5th. By regulating the size of the meshes of nets and seines, and by prohibiting the erection or use of "fish-traps" or "fish-baskets," (we cannot too strongly urge the entire abolition of "fish-traps.")

We would recommend that a small tax be levied on seines, nets and fixed apparatus used to capture fish, and that the tax be in proportion to their capacity of destroying fish.

We would also recommend, in order to better regulate the fishing, that all nets, seines and fixed apparatuses, be licensed, and that "Fish Wardens" be provided, whose duties will be to see the laws enforced in the river districts, and that provisions be made to ensure the observance of the laws in the bay and navigable rivers."

We beg to express the thanks of the Commission to Mr. J. Alexander Shriver, Vice-President of the New York and Baltimore Transportation Line, for 4 Root's steam engines, which will be used for rotating the shaft of the Shad-hatching apparatus described on page 25.

The work of the Commission has been much facilitated by the continued co-operation of the several lines of transportation in the State, and I beg again to acknowledge our obligations to the several presidents and agents of these routes, who have been specially enumerated in my previous reports, as they have continued their assistance in the transportation of live fish, &c.

Respectfully submitted,

T. B. Ferguson, *Commissioner.*

OBSERVATIONS

UPON THE

Hatching, Development and Variation of the

RARITAN RIVER SMELT, (Osmerus eperlanus).

H. J. RICE, B. Sc. CORNELL,

Fellow in Nat. Hist., Johns Hopkins Univ.

Baltimore, December 1st, 1877.

MR. T. B. FERGUSON,

Commissioner of Fisheries State of Maryland.

SIR:—Having been desired by you last March to take charge of, and report upon the methods of hatching the spawn of the Smelt of the Raritan river, N. J., upon which you were about to begin operations, and which was a new field of labor for the Commission, I hereby have the honor to report to you such observations as I was able to make while engaged in embryological work at the headquarters of the Commission.

The field of operations was at the city of New Brunswick, situated about 8 miles from the mouth of the Raritan river, where it empties into the Raritan bay. The Smelt come up the Raritan river from the bay in great schools during the winter and spring months, for the purpose of depositing their spawn; and during this time they are often caught in immense quantities. About five miles above the city of New Brunswick there is a dam which blocks the river, and which the Smelt cannot surmount. They become, thus as it were, shut into a bag, with the blind end near the city. The fishing grounds,

however, may be said to extend from the old wooden city bridge—which connects the city with the country lying N. E. of the river—down the river for two or more miles; very little, if any fishing being done above the bridge, on account partially of the little depth of water, partially because the Smelt appear to pass down the river again, after being impeded in their onward course by the dam The Smelt are caught entirely with seines, which include in their sweep, nearly the entire breadth of the river, averaging about 30 rods.

The seines vary from 30 to 60 fathoms in length, 180 to 360 feet, and are about 15 feet in breadth, with meshes one-half inch square. The time of working the seines depends much upon the state of the weather and the water, but as a rule, the fishermen were engaged early in the morning and again in the afternoon.

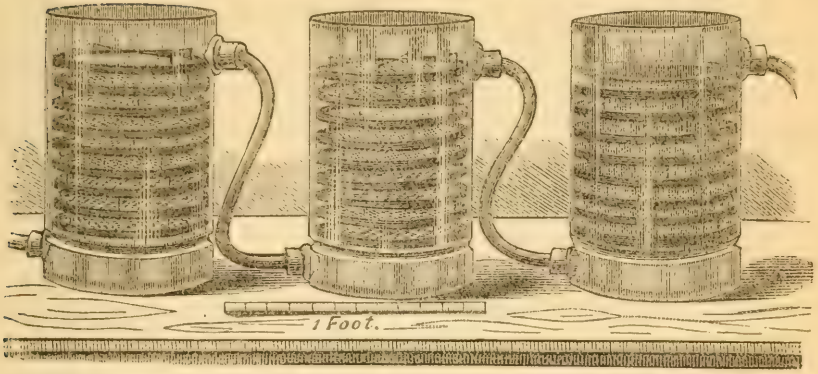
The catch of Smelt from the Raritan was very small the past season—1877—the fish seeming to decrease in numbers every year. This is not to be wondered at, considering the rapacity of the seiners, and their little sympathy, with some rare exceptions, with all efforts at increasing the supply by means of artificial propagation. The small and rather irregular catch of Smelt impeded, to a great extent, the work of the Commission, since at many hauls there were so few fish, that if ripe spawn was obtained, it was impossible to get ripe males to fertilize the spawn, and vice-versa.

And many hauls were entirely fruitless, so far as ripe fish were concerned.

The Commission began its work upon the Raritan on the 3d day of March, by taking possession of a small room in the N. E. end of the bridge-keeper's house, at the bridge entrance upon the S. W. bank of the Raritan, and separated from the river merely by the Raritan and Delaware canal.

In this room the apparatus was erected.

This consisted of six Ferguson hatching-jars,



attached by rubber tubes and stop-cocks to a central tub or reservoir, which was supplied with water from the city hydrant. This reservoir had a waste-pipe passing down its centre, so that the flow of water upon the jars could be regulated as completely as could be desired. The remaining apparatus consisted of trays, pans, pails, dippers, &c. for the purpose of manipulating the spawn. The methods employed by the Commission for the propagation of the young Smelt, were crude and imperfect, to the extent that they were trial methods, and that the accommodations were not such as were desired, but such only as could be obtained upon the spur of the moment, just when it was necessary to handle and care for the spawn.

The Commission had a somewhat difficult work before it, which was the handling, not only of a species of spawn which had never been successfully handled before, but of a species of adhesive spawn, and at the same time, if possible, to bring out a profitable result in the number of young fish hatched. Such work must always be more or less experimental ; if the experiments *happen* to be all right, the result will be very favorable in a fine lot of young fish ; but if the experiments are not all right, the result may be the entire loss of spawn, time, patience and money, and the latter is a very important item in conducting experiments in fish-culture.

Adhesive eggs had been treated, and successfully, before,[1] but it was a question whether the methods adopted in the case of such spawn as that of the Carp, Perch and Herring, would be suitable for spawn of an anadromous species of the *Salmonidæ* family, or whether such spawn should be treated simply as the non-adhesive type.

The only experience in treating Smelt spawn up to the time of the work of the Commission, was obtained by Mr. Charles G. Atkins, of Bucksport, Me. with the spawn of the Land-Locked[2] variety. At least this is the only experience cognizant to the Commission. This experience was not very favorable to the handling of this species of adhesive spawn, and, if I mistake not, Mr. Atkins' conclusions were that it would not pay to handle it.

A certain amount of the spawn which he had, hatched out, but only such portion as had the benefit of, and was exposed to, the full force of a rush of water; in fact, that spawn only hatched which remained attached to grass, twigs, or other articles situated directly in a race-way, where the water rushed along very furiously. The spawn seemed to require, at least for its artificial culture, a constant and furious change of water, differing, undoubtedly, in this respect, very widely from its requirements when deposited by the fish upon its natural spawning grounds. The fish the Commission had to deal with were, on the contrary, anadromous, and we had no *rush* of water in which to deposit the spawn. It was also a question whether the Raritan Smelt spawn required this rushing change of water; so the apparatus already described was employed as experimental upon the subject. The spawn was carried from the fishing grounds to the hatching-house in tin dishes. Sometimes, but rarely, the fish were taken to the hatching-room, and there spawned,

[1] See page 567 U. S. Fish Commissioner's report, 1872–73. Method of treating adhesive eggs, &c. by Rudolph Hessel.

[2] More properly fresh-water Smelt. They are sea Smelt which have been transferred to interior ponds and lakes, and becoming acclimated there, have ceased to return to the sea after they have deposited their spawn.

and the eggs impregnated. In the experiments of Mr. Atkins, he found that leaves of river grass formed the best attachment for the spawn, and that spawn attached to this grass, and allowed to move freely about in the rush of water already mentioned, hatched out comparatively well, whereas spawn treated in any other method, died. The grass, of course, was attached by one end, the other being free to move and sway in the current. The Commission tried various things upon which the spawn was deposited. Bits of grass; bits of untwisted rope warp; bits of gauze hanging free in the jars; loose masses of moss; and light small-meshed gauze, with which the ordinary spawn trays were covered. Many of the eggs, upon being placed in the water of the jars, and before becoming completely attached by the hardening mucous stalk, described, p. 58, would become swept from the trays or other objects, and fall to the bottom of the jars, where they, in some of the jars, formed quite large masses. These latter masses, being directly in the way of the current of water entering the jar, of course received a much more violent and fresher flow of water than the rest of the spawn. They were thus placed in very much the same condition as the spawn which did the best with Mr. Atkins, except that they were massed together, and also, excepting, of course, that the flow in the jars was never *violent*.

Mr. Wm. Hamlin did most of the practical work for the Commission, such as manipulating the fish and caring for the eggs in the jars, &c. The method of gathering and impregnating the spawn was as follows:

Three or four tin pans, with two or more gauze or twig covered trays in each, a tin-pail and a dipper were carried to the fishing grounds. As soon as a haul of the seine had been made, and the fish were all gathered together in small compass close to the shore, or upon it, they were immediately overhauled, and the *ripe* males and females laid to one side. The rest of the fish were gathered up by the fishermen, and

carried off to be sold at so much per bucket. The ripe females were then taken and held by the head, while the belly was gently pressed and stroked toward the anus, so as to force out the ripe spawn. The spawn was caught in a pan containing quite a little water, and when a sufficient quantity had been taken, that is, when the bottom of the dish was half or two-thirds covered, the ripe males were taken, pressed in the same manner, and the milt allowed to flow upon the spawn in the dish.

As the males were, as a rule, considerably smaller than the females, it required very often two, three or even four males to furnish milt to impregnate the spawn from a single female. Sometimes, but rarely, the milt from one male would be sufficient to impregnate the spawn from one or even more females.

Water was then added to the milted spawn, and the contents were stirred slowly and intimately until thoroughly mixed. This stirring was either done by swaying and tipping the dish back and forth, or by stirring the spawn with a feather. After being thoroughly mixed, the spawn was carefully poured upon the trays ready to receive it. Sometimes the spawn was taken directly upon the prepared trays, the trays being placed in water so that the gauze or twig covering would be barely wet, or barely covered with water. The milt was then received upon the spawn, more water added to the dish and the trays moved about gently from side to side, until the spawn and milt were thoroughly mixed. The trays were then carried to the hatching-jars, and deposited therein. With both of these methods of receiving the spawn, there resulted many dead eggs, and perhaps as many by one method as the other.

Ripe males were very scarce at the time when the most and ripest females were procured, and it is barely possible that the percentage of dead eggs was owing more to the lack of milt than to the method of handling. Shad eggs, which are in other respects much more delicate than Smelt eggs,

will bear much more handling than the Smelt eggs received at the hands of Mr. Hamlin by either method used. It was undoubtedly not the roughness of handling which occasioned loss. Another method of taking spawn was adopted. A number of large, unripe male and female Smelts were taken from the seines, carried to the hatching house, and kept in the supply reservoir until they became ripe. The spawn was then taken, impregnated, and placed in the jars along with the rest. On account of the lack of room, no record could be kept of the relative percentage of loss between eggs thus taken and eggs taken from the fish freshly caught. By examining the temperature and fish record upon another page, it will be seen that spawn was taken and placed in the hatching-jars upon 15 different days, extending over a little less than one month, or more correctly, from March 3d until April 2d. The whole number of ripe fish taken for the purposes of procuring spawn and milt being 87 males and 69 females. This irregular catch was due in great part to the almost constant recurrence of freshets, and consequently, risings and floodings of the river. On account of one of these freshets, a very severe one, produced by a long and steady rain-storm, only one catch was made from Friday, March 16th until Friday, March 23d, a space of one week. The ripe fish taken up to the time of this freshet were largely males. They were fairly ripe, and produced much more milt than those taken subsequently. The females, on the contrary, were barely ripe, and only a small quantity of spawn suitable for the purposes of the Commission, could be obtained from each. After the freshet, the females began to increase in number, Friday, the 23d of March, the largest catch of the season being made, and they were riper than those previously taken. From this time on, the females were taken in fine condition until the close of fishing. But the males were now so few in number, and the milt was so bad, that it was with extreme difficulty that the spawn could at times be satisfactorily impregnated. It is quite difficult

to arrive at an accurate estimate of the number of eggs taken from the 69 ripe females and deposited in the jars, but it was very roughly estimated at two millions. This was the estimate of Mr. Hamlin and myself, while at work with them at the hatching house. The estimate is larger in bulk than that attached to the record referred to, for the reason that we wished to give the record as much accuracy as possible, and to certainly have the record within the actual number. Our method of counting was this: I took an average sized female Smelt, removed the ovaries from her entire, took a small portion of the mass, weighed it, and then counted the number of eggs in this small portion.

I then weighed the entire remaining mass of spawn, and from this estimate arrived at the conclusion that there should be about fifty thousand (50,000,) eggs in a medium sized Smelt. By a medium sized Smelt I mean one of the size represented in Fig. 8, Pl. V. But of course many fish will not yield this number of eggs, and many will yield more.

Allowing forty thousand eggs to each female Smelt taken, we would have from the 69 females, a grand total of two million seven hundred and sixty thousand eggs (2,760,000).

But as many of the females were small, and as others did not yield a full amount of ripe spawn, if we estimate that they averaged just one-half that amount, or twenty thousand eggs (20,000,) per female, we shall have very nearly the sum total given in the record.

From the time the Commission began its work until the freshet, the temperature and weather had been fair. The thermometer had indicated a rise in the temperature of the air of about ten degrees, (10°,) and in the hydrant water which supplied the hatching-jars, of two degrees (2°); the temperature of the river had risen, during the same time, six or seven degrees (6° or 7°.) Up to this time the eggs had not progressed very favorably; many had died, and the rest were in such a condition that it was impossible to state as to whether they would survive or not. With the freshet already mentioned,

came a cold spell. The air thermometer indicated a decrease of, at its utmost, eighteen degrees (18°); the temperature of the river sank at same time about 12°; and the hydrant water received a sudden cold to the extent of about three degrees. Up to the end of this cold period, there was barely a sign of development in those eggs which were not certainly dead, and it was questionable what the result would be with the eggs which appeared to be living. But with the storm and freshet, the cold weather appeared to pass away. The temperature of the hydrant water rose steadily, and in a week's time had risen four or five degrees; and of course the rise in the air and river was much greater. With this rise in temperature a change in the eggs became visible; the development could be made out, and it was very soon evident that many of them at least were alive, and seemed in a fair way of producing each its young smelt. About the 26th or 27th of March I took some eggs which had been spawned on the 3d and 5th of the same month, and which showed some signs of development—in fact the embryo could be made out as a mere bar, very nearly alike at both ends, coiled around the yolk—and brought them into the room where I was at work with the microscope, and where the temperature was about 70°. I let them remain in the water in which they were brought in, and only changed it by adding fresh water as the other evaporated. The water which was added was such as had been in the room for some time, so that it was of considerable higher temperature than that of the hydrant. The eggs thus placed in comparatively stale and warm water, rapidly developed, and on the 3d of April a few of the young fish hatched out, or just one month from the time the spawn was taken. In the case of these young fish we ought to deduct at least two weeks, since there was hardly any development of the embryo until the temperature of the hydrant water rose to near 40°. I think it can be said, with a considerable degree of certainty, that after impregnation, a certain, but very small degree of differentiation will take place when the

water is near the temperature of 37° or 38°, Farenheit; if this temperature becomes lowered the development will be retarded or checked entirely, and the vital processes held in abeyance until the temperature again rises to above 38°.

If the temperature of the water is raised much above 38°, as in the case already mentioned, the eggs are merely forced forward, as vegetables and plants are forced in a hot house, and we find the young fish developing very rapidly. The coldness of the water, and the subsequent cold snap lowering still more the temperature of the water, was undoubtedly the cause of the exceedingly slow differentiation which took place in the eggs up to the 20th of March. It has been known for a long time that snail eggs could be impregnated, development started, and then, by means of cold, be kept in a quiescent state for even a year or more, and afterwards, by allowing warmth to come to them, they could be developed into the perfect snail. That to a certain extent the retarding of the development can be made available with fish spawn, is undoubtedty the experience of every pisciculturist, but just to what limits it is best to retard or force the growth of the young embryo, is a question worthy of more study than it has yet received.[1] If the temperature is too low they will be too long developing; if too high they will be apt to be too delicate to survive in any water into which they may be transplanted. From the 20th of March on, the hydrant water rose steadily in temperature until the young fish were all hatched and transported to their final homes in the waters of Maryland. This rise of temperature was from 37° up to 50°, or a difference of 13°. The experience of this year's work with the smelt would seem to indicate that the spawn thrives best in water of a temperature from 40° upward, or perhaps I might say, in water of an average temperature of 44°.

Spawn taken and placed in water of this temperature would undoubtedly hatch out in from three to four weeks,

[1]See an address upon the artificial breeding of fishes, read before the Detroit Scientific Association by Mr. N. W. Clark, page 9, et seq.

and any work with spawn in water of a lower temperature would be in greater part lost time. Between the two extremes I think it would be much preferable, and more profitable to wait until the water is even 39°, before beginning operations, than to subject the eggs and the operators to the benumbing effects of 38°, and lower, of cold, for it is very possible that some of the eggs at least may be injured by this excess of cold. In case however the weather should be very cold again at the time of the work of the Commission, it might be a wise plan to take some of the spawn, dryly and carefully impregnated, particularly if it is very plenty at such time, pack it in ice, and keep it until the temperature moderates to about an average of 44°, and then place it in the hatching jars, and watch it very carefully, recording the result. I have already said that a great many of the eggs died. The greater portion of these dead eggs were upon the bits of grass, rope, moss and twigs, already mentioned, and the greater portion of fish came from those eggs which were taken on the trays, covered with gauze, and those eggs which were massed together in the bottom of the jars, in the strength of whatever current there was. The live fish which were hatched from the million and a half, or more, of eggs, were estimated at about four hundred thousand, (400,000), the remaining eggs being classified as "absent or unaccounted for." The work of the Commission may, with this result, be said to have been very successful, considering everything. I have said that the greater portion of these dead eggs were upon the moss, twigs, ropes, &c. and we might be led to judge that these objects were not as fitted for supports to the smelt spawn as the gauze, or the bottom of the jars. But it may be that these articles are not so very much to blame after all; perhaps they are only fitter than the gauze to retain and encourage the growth of a species of fungus which was found in very great abundance in all the jars, sometimes covering the eggs upon the trays to a depth of an eighth of an inch or more.

This fungus, thus covering the eggs, must have a very deleterious effect upon them, and I do not think it would be very wrong to ascribe to it the death of a goodly portion of the eggs.

In considering the practical bearings of the work of the Commission during the past season, it may be useful to note a few points to which it will be well to pay particular attention, and record carefully the results during another year's work.

In handling eggs of any kind, the dry method[1] of impregnation should be adopted upon all occasions: that is, the eggs and milt should be placed together *before any water whatever is added;* a little water should then be added to the mass, and the whole shaken together quickly, yet completely, until the eggs and milt are thoroughly mixed; then more water should be added, a second shaking given, and after standing ten or fifteen minutes, the water, or the greater portion of it, poured off, and fresh added.

The eggs are now to remain quiet until transported to the hatching jars, and placed therein. I am convinced that this is the only practical method with adhesive spawn, and particularly with Smelt spawn, and I think the best results will follow, if the trays, covered with fine gauze, are used, upon which to receive the spawn and milt fresh from the fish. The meshes of the gauze covering should be just a little smaller than the diameter of the eggs, so that they will not pass through before they have had time to become attached. The gauze should be just dampened, the trays placed in a pan, without water, and the spawn shed upon them, the milt then being shed upon the spawn.

Water is then to be added, just sufficient to cover the trays, the whole shaken gently from side to side, so that the whole mass may be thoroughly mixed, but not so much that any of the spawn will be shaken from the trays, the spawn left

[1]Vrasski's method, as modified by Mr. C. G. Atkins, in his work upon the Salmon spawn. See United States Fish Commissioner's Report 1872–73, page 240.

to stand for ten or fifteen minutes, and then shaken again, when the water may be changed, by lifting the trays out of the pan, and fresh water added; the trays may then be transferred, covered by water in the pans, to the hatching jars,[1] in the hatching house. In a very short time the mucous covering the egg will harden, and adhere to the gauze upon which it rests, and the egg will thus be attached firmly to its support. This method gives the least handling to the spawn, and accordingly the least chance for injury to the same. I have already intimated that perhaps a goodly portion of dead eggs were caused by there not being sufficient milt to impregnate all the eggs in any one dish.

Generally a considerable quantity of milt is considered necessary, because very little time is given to the manipulation of the spawn; and certainly the greater the amount of milt, the less the time necessary in manipulating. But with a very little milt a large number of eggs may be impregnated, if sufficient time is given, and the whole is well manipulated. The spawn and milt must also be fresh from the fish, and *brought together immediately*, upon water being added to either, since water soon acts upon the spawn, so as to prevent any effect upon it by the milt, unless the milt is added *very soon*. The method mentioned seems to combine all these requisites, and in the case of the spawn already mentioned, had the manipulation been more prolonged when milt was scarce, perhaps fewer eggs might have died. And I have no doubt at present time, that if, besides additional manipulation, the spawn and milt had been placed together dry, before any water at all had been added, a still larger proportion of live eggs would have been the result.

To obviate any such chance of lack of milt, although the stirring and shaking of the eggs should in all case be con-

[1]It will be noticed that I always speak of the *hatching jars*, meaning thereby the Ferguson hatching jar. This apparatus is so simple, and so exactly adapted for the purposes of hatching eggs or spawn of any description, that after trial I think no one will care to use any other description of hatching apparatus.

tinued for ten or fifteen minutes, the plan of keeping unripe fish in a reservoir until ripe, and then spawning them, should be adopted more extensively than this season.

They should be kept in a reservoir separate from that which supplies the hatching jars with water, since the fish are apt to be drawn against the openings into the supply pipes for the jars and the water thus cut off from the spawn, and stagnant water favors fungoid growths. They should also be examined carefully each day, so that as soon as ripe the spawn and milt may be taken from them, and yet not taken from them until they are fully ripe. In this manner a large quantity of spawn should be obtained, and unless the fish are injured there is no reason, so far as at present known, why such spawn should not turn out as well at that of Trout kept in a similar manner. Spawn taken from fish thus kept should be placed separate from that of spawn from fish taken fresh from the river, and the two carefully compared, after, of course, the same manipulation, so as to see which method is the better; records, of course, being kept of each. In making this experiment the largest fish should be kept as furnishing so many more eggs, or so much more milt than the small ones. But to carry out this experiment, more room will be required than was at the service of the Commission this season, and it would undoubtedly be better if accommodations of sufficient size could be secured near the fishing grounds, so as to obviate as much as possible the transfer or carriage of fish and spawn. The treatment of the eggs, after they are placed in the jars, does not differ materially from that of other spawn. A constant flow of water, and since the eggs adhere to their support, a much stronger flow through the jars, can be permitted, than with other eggs; clean jars and trays; and the removal of dead eggs. The removal of dead eggs, in the case of the Smelt spawn, is almost practically impossible, on account of the adherence of the eggs to each other, as well as to the sup-

port, and also, and chiefly, on account of their small size. Fig. 5, Pl. I.

But much can be done, with pains and attention, towards keeping the trays comparatively clear of dead material, and the greater the care and attention, the greater the success ought to be.

The only remaining point necessary to notice particularly is in regard to the dirt and fungus in the jars. Of course, in all waters subject to freshets, there will be more or less of sediment and floating material, which does not add at all to the purity of the water. The only way to prevent this material from getting into the jars, and collecting around and upon the eggs, thus forming an excellent basis for fungoid growth, is to have the water filtered before it is allowed to enter the reservoir which supplies the jars If the Commission should conduct operations upon the Raritan another year, and should use the river water, it would certainly have to be filtered, or the jars would very quickly be filled with sediment. If the hydrant water is used, it also should be filtered, although, as compared with the river water, very free from floating material. As regards fungoid growths, they appear to get into the jars about as easily when the water is filtered as when it is not, the only, or at least the great difference being, that in unfiltered water there is a vast amount of vile material which fosters and encourages these fungi. The best method of disposing of them is to give the eggs, as soon as any fungus appears upon them, a salt water bath. Let the water be shut off from the jars, a table spoonfull or so of salt added to the water in each jar, and then allowed to stand for fifteen or twenty minutes, when the water should be turned on again. The salt will effectually kill all the fungi, without injuring the eggs, and the renewed flow of water will carry off the salt and the dead matter in its flow. As soon as the fungus again collects upon the eggs, they should be treated to another salt bath.

If any doubt is felt in regard to any possible injurious

effect which the salt might have upon the Smelt spawn, a trial could be very easily made of one of the jars only, and the result noted, i. e., as to whether there were any more dead eggs in the jar after the salt bath than before. The salt bath is very effectual, and perfectly innocuous with Trout eggs and aquaria, and there is no reason to suppose it would be otherwise with the eggs of the Smelt. With the growth and extension of fungi in the jars thus prevented, and with that care in the manipulation of the spawn which I have suggested, the Commission ought, with the experience of the present season, to be able to work as successfully hereafter with Smelt spawn as they have shown themselves to be with spawn which is non-adhesive, such as that of the Trout and Shad.

The work of the Commission, from necessity, as well as inclination, is to increase the food supply as profitably to the State as possible, and while the matter of profitable propagation rests to a great extent in the hands of the Commission, through the experience which is gained each year, yet other circumstances enter largely into these calculations, such, for instance, as their ability to do as they would like, and to work just at the time they desire. If in the propagation of the Smelt the Commission could so arrange their time for work upon the Raritan as to be there when the temperature of the water used in the hatching jars is from 42° to 44° at an average, they would undoubtedly meet with the greatest and best success, especially in a pecuniary point of view, since at such a temperature the young fish could be hatched out in about three weeks.

The most serious objection to this plan is in the running of the fish themselves, the greater portion of the fish passing into the river earlier in the season. But if the method is adopted of keeping the males and females in confinement until ripe, even this objection might have very little weight, and the spawn might be handled at a time when it could be so done most expeditiously and profitably.

In recapitulation, I might say that the important points to the Commission for its work another year would be, 1st, the procuring of suitable fish. 2d. The careful manipulation of the spawn *absolutely dry*, or the nearest convenient approach to it. 3d. The temperature of the water, about 44°, and its freedom from fungi.

EMBRYOLOGY OF THE SMELT.

The following notes upon the embryology of the Raritan river Smelt were made in March and April, 1877, at New Brunswick, N. J., while the Commission was engaged in prosecuting the hatching of Smelt spawn, the methods of which process have already been described. I do not intend to treat of the histological development of the Smelt—or of its minute cell structure—except so far as it can be made out in the living specimen; since a histological study, made from sections cut from hardened specimens, is of value and interest only to science and scientific students, not to the general reader. This paper will, therefore, serve merely as the basis of what I trust, at some future time, to make a histological research, and hence, must be taken with that allowance for error, both in the personal equation and the equation of sight, to which all research is liable when unauthenticated by collateral or different methods.

My method of study was either to take the eggs from the hatching jars, one or more at a time, and examine them upon a watch-glass in a few drops of water, or to dissect the vitelline membrane or shell from the egg, and examine the uncovered embryo in a drop of water, or sodic-chloride, Na. Cl. ½%, upon a glass slide, under a low objective in the microscope. In this manner I examined egg after egg, until I became satisfied upon any or all observed conditions, and was able to trace a pretty clear sequence of developments. My investigations were made with Zeiss oculars 2 and 4, and objectives A and B, giving a range of power from 90 to 400 diameters.

In the case of the milt, I used Zeiss ocular 4, and objective F, giving an enlargement of 950 diameters.

The Egg.

The freshly laid egg varies in diameter from $\frac{1}{50}$ to $\frac{1}{30}$ of an inch, and is somewhat irregular in outline, although generally round or oval. Fig. 1, Pl. I. The number of eggs which an average size fish will spawn is about forty thousand. I estimated, by weighing and counting, the number in a female Smelt $7\frac{1}{4}$ inches long, from Little Narragansett Bay, R. I., to be seventy thousand, and this after making due allowance for errors. The average length of fish from the Raritan river is less than this, and will not fall far short of 5 inches.

The eggs, as they issue from the female, are enclosed in or surrounded by a mucous or viscid substance, which seems to form a sort of protection for the egg. This viscid substance has a tendency to adhere to whatever it touches—and, although the eggs separate as soon as they touch the water, yet if in passing toward the bottom they touch any object, such as a leaf, twig, or bit of weed, they remain attached to it. The water then appears to act as a hardening agent upon this viscid coating, causing it to "set" in the form of a sack around the egg, with a slender stalk or handle between the egg and its attachment. Fig. 8, Pl. I. Sometimes a number of eggs remain in a little bunch together, or are gathered together by falling one upon another; the "setting" of the mucous around each one then transforms them into a cluster, Fig. 5, Pl. I, much resembling the egg clusters of the Cray-fish. This outer coating of the egg or ovum presents a granulated or dotted appearance as if having a great number of pores or openings; but I have been able to discover no openings in small pieces of the shell, even with Zeiss ocular 4, objective F, and am inclined to believe it the effect of the hardening or "setting" process.

Fig. 8, Pl. I. The unimpregnated ovum or egg, freshly taken from the female and divested from the mucous coating, presents a vitelline membrane or shell entirely filled with highly refractile oil globules of very nearly uniform size. These oil-globules constitute the vitellus.

The vitelline membrane has upon one side a very prominent depression or pit—the micropyle—with an undoubted opening or pore at the bottom. Figs. 1 and 2, Pl. I.

This micropyle at first indents the mass of oil-globules, but as soon as the egg passes into water, some of it is absorbed, and the vitellus shrinks in bulk and occupies a smaller space in the centre of the egg. Fig. 2, Pl. I.

From the absorption of water the micropyle soon becomes obliterated and its place simply indicated at first by a slight protrusion of the vitelline membrane, Fig. 3, Pl. I, afterwards by a puckering of the surface, Fig. 4, Pl. I, which is observed in some eggs when the embryo is very far advanced. In many, or perhaps most eggs, however, all traces of the position of the micropyle disappear soon after impregnation.

The absorption of water slightly increases the size of the ovum, although very slightly, the great change being the concentration of the yolk-mass. This distention of the vitelline membrane of course has very much to do with the disappearance of the micropyle. The micropyle is not constant in position as regards the stalk of the mucous sack, nor as regards the position of the embryo, sometimes being over the head, sometimes over the tail, sometimes to one side.

This latter relationship, however, is of no special importance, since the yolk-mass is movable, and the position of the micropyle, with relation to the embryo, thus a constantly changing one, with every motion of the egg. After the absorption of water, the concentration of the yolk-mass, and the filling out of the vitelline membrane, the vitellus or yolk-mass becomes somewhat changed in character; the oil-globules unite one into another directly, forming larger spheres in the centre of the mass, with smaller ones filling

up the interstices and forming a layer around the outside or periphery. This change continues until the outer portion assumes a mottled granular appearance. One side—and it is always on the side—then assumes a lighter shade, becomes very evenly, finely granular, and forms a less or greater protuberance from the vitellus. Fig. 3, Pl. I. This form continues with more or less distinctness, sometimes assuming the fissural condition of segmenting or impregnated eggs, until the yolk gradually turns white, disintegrated, and dies.

I was unable to find among the oil-globules of the vitellus, any germinal vesicle with its germinal dot, although I opened a great number of ova, and examined the contents with Zeiss ocular 4 and objective D, giving 400 diameters enlargement. I did find, however, in most of the ova, a small bit of granular tissue, which may represent the germinal vesicle, or more properly, perhaps, the blastodermic tissue. I am inclined to think that the germinal vesicle undergoes a differentiation during the period of ripening of the egg; and although no true segmentation takes place until after contact with the male element, yet a granulation takes place which changes the vesicle with its contents, into blastodermic tissue, ready to be segmented and still further differentiated upon contact with the male element, or without contact, to disintegrate. It is highly probable that in an earlier stage than I have examined, the vesicle, with its contained germinal dot, can be found.

Spermatozoa.

The milt in the male occupies relatively less bulk than the spawn in the female; and the males can thus be designated from the females, during the spawning season, by their more slender form, there being very little of what is vulgarly known as pot-belliedness about them.

The spermatozoa or male elements are very numerous in the milt, and present an appearance very much resembling grains of wheat, Fig. 6, Pl. I, rolling and jerking across the field of the microscope. In some of the spermatozoa I discovered a very slight prolongation at one end, but other than this, could see no indication, either when in motion or still, of any tail, or long, slender, filamentous appendage such as is found in all other vertebrate spermatozoa, so far as my knowledge extends. The spermatozoa are very small, however, and as I had no means of viewing them with greater magnitude than 950 diameters; and as they then appeared mere specks upon the field, this observation in regard to the tail is far from reliable. How and where the spermatozoa pass through the vitelline membrane into the ovum, and impregnate it, has long been a mooted question. That in this species they pass in through the opening in the micropyle, however, and are drawn in with the water which the ovum absorbs, cannot, I think, be questioned.

At least this much is known, that if the dry method of milting the spawn is adopted: that is, putting the milt and spawn together before any, or when very little water has been placed with the spawn, and afterwards placing them in water and shaking together gently, the proportion of eggs which fail to be impregnated, or to do well, is very small indeed; but if the spawn be allowed to remain in water for even a very short time before the milt is added, in fact, until by absorption the micropyle has become obliterated, the proportion of eggs which turn out unimpregnated and bad is very large indeed. To test the question as to whether spermatozoa were actually taken into the ovum during this season of water absorption, I took a Smelt egg which had had milt shed over it, and as soon as it had ceased absorbing water, or as soon as it was apparently full of water, carefully removed the mucous and washed it in six waters, so as to remove any spermatozoa which might be upon the outside. I then took off the vitelline membrane, and allowed the yolk

contents to escape upon a glass slide. The escaped vitellus was then examined with Zeiss ocular 4, objectives D and F, and I was able to discover a few spermatozoa among the oil-globules.

This may be considered as not entirely conclusive, but it is questionable if any *more* conclusive method can be adopted, since it is utterly impossible to see the spermatozoa penetrate the ovum through the vitelline membrane, either at the micropyle or elsewhere, on account of the relative sizes of ova and of spermatozoa.

Impregnated Ovum.

For quite a time after the ovum has been impregnated, there is no perceptible difference in the changes which take place from those in the unimpregnated egg. One side becomes clearer, Fig. 4, Pl. I, with fine granulations, a portion protrudes, and then take place those segmental phases, some of which are represented in Figs 9, 10 and 11, Pl. I

These changes were very slow in taking place in the eggs of the Smelt, probably on account of the sudden lowering of temperature which took place about the time that most of the eggs were taken and continued for a week or more. Hence many of these changes were overlooked in the confusion of observing ova in the earlier phases, and all stages of living and dying, and accordingly I lack a complete series of the segmentation stages. These stages are undoubtedly similar, however, to those in the egg of the shad, a description of which changes will be given in another place. The fine granular portion which results from this segmental differentiation, gradually extends for quite a distance around the periphery of the egg, Fig. 7, Pl. I, and represents the blastodermic tissue, or simply blastoderm, from which the young fish is to be built up. Previous to, or during the formation of the clear granular portion, there were no indications of any polar globules* at this or any other portion of

* Richtungsblattchen or direction cells of authors.

the vitellus, but merely the protrusion of one side into a more or less prominent limb. Fig. 3, Pl. I. In certain ova, however, glomeration did take place: that is, round balls, sometimes one above the other, formed irregularly over the blastodermic tissue, and I noticed that such formations, in both Smelt and Shad ova, heralded always the disintegration of the vitellus. Sometimes this glomeration took place after the embryo was considerably formed. In all cases, however, no further development took place, the ovum soon becoming opaque and dead. Coincident, or nearly so, with the extension of the blastoderm is the formation from the blastoderm over the entire surface of the vitellus, of a layer of cells, the exoderm, (epiblast),* which forms the outer coat or skin of the embryo.

The folding which this layer undergoes along what is to be the dorsum of the embryo, I was unable to make out satisfactorily, on account of the difficulty of keeping the blastoderm in a proper position for study under the microscope. Almost as soon as it was got into a good position, it would roll slowly back to the side. I thought I made out, however, in a number of specimens, the folding in different stages of its progress.

This folding consists of the growing up along the central portion of the blastoderm of two laminæ or ridges from the exoderm. These laminæ finally unite along a median line, leaving a central cavity or tube the length of the folding,

* I use the terms *exoderm* and *endoderm* as being more exact in meaning than epiblast and hypoblast. The exodermic layer is with fishes, very rarely formed upon the *upper* side of the blastoderm, yet, according to the meaning of the terms, when the epiblast is formed below, or on the lower side of the blastoderm, it would become the hypoblast. In the same manner the hypoblast or under blast, when formed above the blastoderm, would become the epiblast I use these terms also because they are used for similar or homologous structures among the lower forms of animal life. And similarity is much to be desired in names bearing upon or attached to homologous structures.

which forms the neural or spinal arch of the embryo, or the arch in which the spinal cord is formed.

Within the exoderm, and from the within-lying cells of the blastoderm, two other layers are subsquently formed—the mesoderm or middle layer, and the endoderm (hypoblast) or internal layer. From the folding in and union of these two layers in conjunction with the exoderm, a second arch, the body or alimentary cavity, is formed. The further growth of the embryo then takes place through differentiations, either slow or more rapid, in the three layers making up these two arches. The first indication in the egg of the Smelt of anything approaching a fish or animal in form, is represented in Fig. 1, Pl. II.

Here the folding in of the exoderm to form the neural arch is nearly completed, the anterior and posterior ends being still open, although only the anterior end can be seen. At this anterior end is seen quite an enlargement, which represents the swelling of the cerebral vesicles, or what will eventually become lobes of the brain. This end increases still more in size, the lobes appearing to swell out with a more rounded appearance, and just before the anterior end of the neural canal closes, round, disk-like markings appear upon the middle portion of the sides of the head—as we shall hereafter call this end of the embryo. These markings, Fig 2, Pl. II, represent the first indications of the eye-balls.

The head presents, at this period, a very dumpy or club-shaped appearance, with its prominent lobes and rather thick lip-like edges of the closing neural canal. Very nearly with the appearance of the eye protuberances, or very soon after, can be seen a cylindrical tube containing two rows of large cells side by side, which barely touch in any part, and are somewhat scattered posteriorly, extending nearly the entire length of the embryo, just along the ventral side of the neural arch. This is the notochord or the axial portion of the future back-bone. Fig. 2, Pl. III. It ends anteriorly, with a quite abruptly bent extremity, just on a line with the pos-

terior edge of the eyes; and posteriorly loses itself without bend in the tissue near the centre of the tail, just ventral to the closed end of the neural canal.

Closely investing the notochord, and coincident with its formation, can be seen a sort of blocking-off into cell-like sections in the posterior, two-thirds of the embryo. Fig. 4, Pl. II. These sections or proto-vertebræ are not seen in the anterior third, but become gradually lost in the tissue. They are bounded by a well marked line, which passes parallel to and at some distance from the contour line of the body, around the posterior end of the notochord, and proceeding forward, becomes lost in the tissue coincident with the segments themselves. These segments gradually increase in number with the growth of the embryo.

The least number which I noticed in any specimen after the head was differentiated so as to be distinguished, was 24; from this they increased up to 50, beyond which number I believe I did not count.

The portion thus segmented becomes eventually the harder, axial part of the body, containing the greater part of the osseous material, the spinal cord and the main blood-vessels. Up to this time, the embryo has been united throughout its entire length to the vitellus. But a change soon takes place; the layers of the embryo, which meanwhile have been forming from the tissue lying within the exoderm, begin to fold in to form the second cavity. This frees the posterior end of the embryo gradually from the vitellus, and allows it to project between the vitellus and the shell membrane, where, by the growth of tissue and multiplication of segments, it gradually extends until it wraps itself completely around the yolk, and passes by the head on the opposite side. Fig. 7, Pl. II.

As the tail becomes free, the eyes become more prominent, and the ears are indicated by slight depressions in the exoderm upon the sides of the body, just over the bend in the anterior part of the notochord.

A depression of the exoderm now takes place over the center of the eye-ball, which, being a mere sack, is depressed into a one-sided cup to receive the bit of exoderm. This bit of exoderm is then surrounded and enclosed by the sides of the cup, it becomes detached from the exodermic layer, and becomes gradually transformed into the chrystalline lens. As the lens and cup undergo changes, the edge of the cup is so modified that it shuts in the lens much as a watch glass in a watch is enclosed by its rim. Fig. 9, Pl. II. This closing of the eye-sack around the lens, is from the dorsal towards the ventral side, and after the lens is completely embedded, the line of contact of the sides of the sack can be seen running from the edge of the lens down and along the ventral surface of the eye, until it becomes lost in the brain mass Fig. 1, Pl. III.

By this time the ear cavity has become quite prominent, surrounded by its hemisphere of columnar cells, with the otoliths becoming visible as small transparent bodies in the ventral side of the bottom of the cavity. Fig. 5, Pl. II. The brain can also be made out as a tube-like body, with a prominent, posterior fold, open at both ends and along the dorsal side, and having a diamond shaped expansion of the dorsal slit about two-thirds the distance from the anterior end. This expansion represents the third ventricle. The posterior fold presents two laminæ, curving upward, inward and forward, which gradually grow together, and ultimately unite upon the median line dorsally, to form the cerebellum; the depression just posterior to the fold, or the posterior open end of the brain, becoming the fourth ventricle. The eye sacks appear attached to the central ventral portion of the brain tube. Fig. 9, Pl. II.

They are in fact expansions, and hence, differentiations of the middle cerebral vesicle. The nasal pouches are indicated at this time, by circular markings just anterior to the eyes. As the infolding of the layers continues, or more properly, as the embryo grows away from its original con-

nection with the yolk-sack, the organs which have indicated specialization become still more highly specialized. The eye acquires pigment granules: the ear becomes nearly enclosed by the approximation of its walls, and the otoliths are three quite prominent dark bodies; the nasal pouch has deepened and rests against the anterior dorsal portion of the introverted brain; the brain has increased in size, and shows indications of the different portions into which it is subsequently divided; the head, which up to this time has remained attached to the yolk mass, becomes free as far back as to the posterior edge of the eye; the first indication of an intestine, is seen in a blind hollow space in the tissue, where the tail is growing away from the yolk, Fig. 2, Pl. III; and beneath the ear, at the junction of the embryo with the yolk, is a rather sharply marked tract, rounded posteriorly and somewhat pointed anteriorly, in which the heart soon is formed from the mass of loose cellular substance therein contained.

The branchial fissures are indicated at this later stage, by two or three streaks or slight transverse linear depressions along the sides of the body, posterior to the eye-balls.

Fig. 2, Pl. III, represents the embryo at a period a trifle later than this, or just after the formation of the heart, and about the time it begins to beat or pulsate. The embryo has been removed from the egg, by tearing apart the vitelline membrane, the yolk remaining unruptured. The embryo nearly surrounds the yolk; the tail, up to where the vent or anus will be, and a small bit of the head, being free. The heart is plainly visible, and the branchial lineations indicated. The endoderm is now represented as the lining to the alimentary canal or intestine, or at least such portion of the canal as now exists, since the blind posterior extremity thus far alone is formed, and is all that represents the future intestine, the remainder of the to-be canal being filled up with the mass of the vitellus. Very soon, however, there takes place from below the ear, backwards, an infolding of

the layers of the blastoderm, forming, beneath the ventrally bending end of the notochord, an anterior cæcum. Meanwhile the infolding at the posterior end has been going on, so that now we have something much more like a canal; two cæcal extremities with connecting dorsal and lateral walls, and a ventral wall, open for a space along the centre over the yolk, thus still giving the embryo a connection with its food-bag, the vitellus, through the intestine. Fig. 1, Pl. III. The walls of the intestine are of course formed by the layer of endoderm. At this time, and before the intestine is entirely shut off from the vitellus by the infolding blastodermic layers, a large vacuole appears pulling out the body wall where the anus eventually opens, and separated from the posterior end of the blind intestine by quite a mass of loose cell substance. Fig. 3, *b*, Pl. III.

The heart is now becoming quite well defined, and is beating at the rate of about thirty-five pulsations per minute. At first the heart is somewhat more rounded at one end than at the other, forming a simple sack, consisting of a layer of columnar cells, and attached by bands of tissue at either end to the body proper of the embryo. I do not mention whether anterior or posterior end of the heart is the rounder extremity, because I am not positive from the observations made, that the rounder end is constantly in the same position. If I was to make an assertion, I should say that it was not constant.

Soon the heart becomes elongated and tubular, Fig. 4, Pl III, and its action in beating is much like that of a water-wave. The impulse begins posteriorly by expanding the posterior part of the tube, thus pushing the lower back portion of the tube still farther back towards the yolk mass, and stretching nearly straight the remaining portion.

The impulse then passes forward, allowing the posterior part to return to its former position, and swelling out the central portion until the impulse and dilatation have passed to the anterior extremity, when the conditions are just the

reverse of what they were at first. The action taken as a whole, is very much as if we took hold of the heart by one extremity and by a quick twitch should send a wave of transtation from one extremity to the other. This gives a very curious and beautiful effect, as seen under the lens.

The heart soon looses this tubular form, becomes thicker at the posterior extremity and constricted in the middle, and passes by gradual steps into a two chambered organ. Fig. 5, Pl. III. Figs. 1, 2, 4, Pl. IV. At the same time it increases in its number of beats per minute, up to seventy, beyond which I believe I did not count. Nearly simultaneous with the assumption of the tubular shape of the heart, vesicles appear in the body tissue along the side of the body at the anterior end of the alimentary canal, between the branchial surface depressions already noticed. Figs. 1 and 5, Pl. III, Fig. 1, Pl. IV.

These vesicles increase in number until there are five on each side. The tissue composing their inner and outer walls then appears to grow thinner, until finally an opening takes place on the inside into the alimentary canal. Fig. 1, Pl. IV. The vesicles then disappear, and we next have the five branchial slits in their places. Fig. 3, Pl. IV. These slits represent the future branchial or gill openings, or the spaces between the gills; and the bits of tissue between the slits represent the future branchial arches, or become what are more commonly known as gills, there being four on each side, or four pairs in all, in all osseous or bony fish. The anterior border of the first branchial slit gradually grows backward, covering the rest of the openings, and becomes the operculum or gill-cover. Before this change takes place, however, and while the branchial fissures are yet mere slits through the tissue of the body walls into the alimentary canal, the yolk mass has been growing smaller and smaller, and the oil globules have been merging into each other, until we have a large spherical oil-mass or globule formed in the fore part of the yolk sack, Fig. 4, Pl IV, and the remainder of the yolk

composed of a finely divided granular mass, with the yolk at last entirely separated from the intestinal tract by the infolding blastodermic layers. A depression now takes place in the anterior end of the body and upon the under surface of the head, and gradually deepening, until it reaches the anterior end of the already formed intestine, becomes the mouth and œsophagus. In Fig. 4, Pl. IV, this newly formed mouth opening is represented, together with the general shape of the heart; the shape of the yolk mass; the ear now enclosed, with its otoliths; the pectoral fin, which began to show at about the time the heart was in its tubular condition; the notochord with its double row of cells, only one row being visible; and just beneath the notochord, the intestine which has now become either a solid rod of cell material or a tube with the merest trace of a central canal—this can only be decided by sections, which I have not as yet made.

Figs. 5 and 6, Pl. IV, will give an idea of the posterior end of the body, and the portion at the posterior extremity of the intestine, at about this time. These portions are very much enlarged, and show that a differentation is taking place in the tissue between the intestine and the notochord, and two separated tracts *a* and *b* are forming in which shortly the great blood-vessels are to be found. These tracts are not as yet extended as far back as the posterior end of the notochord, but their formation is indicated by spaces in the tissue along beneath the notochord. Fig. 5, Pl. IV. A magnified view of the anal portion of the embryo at the time of the formation of the anterior end of the intestine, and while the anal vesicle is still to be seen, shows that these two tracts are forming even then in the tissue above the already formed posterior end of the intestine. Fig. 3, *a*, Pl. III. At the time of development represented by Fig. 6, Pl. IV, the anal vesicle has disappeared, and the cellular mass indicates plainly an outlet tract, although no vent is as yet present between the posterior end of the intestine *c* and the exterior. Up to this time, the young fish has been retain-

ed by the vitelline membrane within the egg. It now, however, at about this stage of development, becomes free from the egg, and swims freely about in the water, looking to the naked eye very much like an animated bit of isin-glass with two black dots at the end. At this time it is somewhat less than three-eighths of an inch in length, and being very transparent, could hardly be seen in the water, were it not for the comparatively large black eyes. Side and top views of the young Smelt at this stage, but very much enlarged, are given in Figs. 1 and 2, Pl. V. Most of the structures and organs already mentioned can be readily seen: the intestine passing along the centre of the body beneath the notochord and above the yolk mass, from mouth to anus; the heart with its posterior and anterior attachments, now not only divided into two distinct portions, but relatively much smaller than heretofore, and the auricle crowded forward upon the ventricle; the ear with its forming semi-circular canals; the nasal sack somewhat closed; the prominent pigmented eyes; the much enlarged pectoral fins; the yolk mass, now much absorbed in nourishing the body, and gradually becoming enclosed by the body walls; and the quite advanced brain. The further stages of the brain may be seen by consulting Figs. 10, 14 and 15, Pl. V. In Figs. 10 and 15, Pl. V, the brain presents the same general features as in Fig. 2, Pl. V, with the exception that all the divisions are more strongly marked.

The posterior lobes are gradually approaching each other to unite on the median line dorsally, and form the cerebellum, while the prominent portions immediately in front of the cerebellic divisions are thickening and rounding out to become the optic lobes, and the anterior part is also changing form to finally assume the shape of the cerebral and olfactory lobes. In Fig. 14, Pl. V, these parts are represented as seen in the adult fish and of natural size. The brain, as thus seen from above, forms what the fishermen call the "old man's face," seen in the adult Smelt, through the

semi-transparent skull, by scraping off the over-lying skin. Soon after the stage represented in Fig. 1, Pl. V, the young Smelt begins to undergo quite considerable changes in form; the head is no longer roundish or blunt in front, but becomes sharp and rather shovel-nozed, from the rapid extension of the lower jaw or mandible: the yolk mass is entirely within the limits of the body, and fast disappearing; the vent has formed, and there is a marked depression of the body between the heart and the anterior extremity of the yolk; the intestine again shows as an open tube, with the portion from the yolk to the anus much broader and larger than anteriorly: the heart is in shape much as before, but now a few small particles can be seen moving around in the cavities of the auricle and ventricle, and the anterior and posterior connections of the heart with the body are much more marked. These are all represented in Fig. 4, Pl. V. During this last stage, vessels have been forming in each visceral arch, and one very prominent one, and traces of a second, in the tissue anterior to the first visceral cleft, or in what we may now call the operculum.

These vessels gradually extend themselves upward along the arches and sides of the head, until they reach the level of the ears: from this point they vary in their development both in time and form. The prominent vessel of the operculum, which is really the second branchial aorta, and will be spoken of as such henceforth, developes very rapidly, and, from the position it has already attained, turns forward, downward and inward, and having reached a position just inside the eye ball, divides into three branches, one branch going into the ball of the eye and passing around the chrystalline lens, emerges and passes backwards: one branch goes forward to the fore part of the brain, bends around this and returns nearly upon itself: while a third branch passes inward and upward into the brain tissue, to unite on the median line and near the centre of the brain, with its twin branch from the second branchial aorta of the other side.

Almost as soon as they unite they again divide, a branch passing to each side through the brain tissue, and at a point somewhat posterior to their division, they unite with the two returning branches already mentioned, to form lateral vessels, one on each side of and just along the base of the brain, which pass into the auricle, and so form a complete circuit of vessels for blood transmission; for by this time a passage has been made from the ventricle along the floor of the head, and just beneath the œsophagus, to the already mentioned branchial vessels.

Through the passage-way thus formed, a flow of blood, or some kind of fluid containing roundish or irregular bits of tissue material, takes place. This flow of blood serum, with its white or transparent corpuscles, through the 2d branchial vessels, forms, in the young Smelt, the first blood-system, which is entirely a head circulation. Fig. 3, Pl. V. The same thing takes place in the Shad. Up to this time no connection exists between the rest of the branchial vessels and the 2d vessel, or between each other. But soon the 3d, 4th and 5th vessels turn forward and unite into a common vessel, which passes forward to supply the head and brain with blood, and which, sooner or later, unites with the dorsal branch from the 2d branchial vessel, since all the branches eventually unite into the vessels (jugular veins), which run along the basal side of the brain to return the blood to the heart. The sixth branchial aorta, which originates from the fifth, passes directly upward, inward and backward, until, upon the median line, it unites with its fellow branch of the opposite side to form an open, isolated tube around the head, which has connection only with the ventral aorta through the fifth vessel, just anterior to the bulbus arteriosus, which, by this time, has formed in front of the ventricle of the heart, and connected with it. During the time the first circulation is in progress, corpuscles can be followed from the heart into these posterior four pairs of partially excavated vessels, where they are stopped in their onward

flow, and the corpuscles perform piston-like movements, back and forth, to and from the closed ends of the vessels, at each and every pulsation of the heart. Sometimes the corpuscles form quite a mass in these closed vessels.

They get out of the main blood flow, are driven into the vessels, and become clogged in these until the vessels open at their extremity. Shortly after this, a dorsal, lateral communication is made between the 5th and 6th vessels: then we often see corpuscles passing up from the ventral aorta into the 5th vessel, and from this through the new channel into the still closed 6th vessel: or corpuscles will often pass into the 6th vessel, and when they come to the channel to the 5th, pass into it, and so on into the circulation. It is only a short time after this, and often perhaps coincident with the formation of the connection between the 5th and 6th vessels, that an opening takes place in the median line of the ventral side of the united 6th pair of vessels, and this opening leads into the dorsal aorta of the body. The body aorta passes directly back to near the extremity of the notochord, where it bends upon itself and returns as the vena cava, just beneath the aorta, to empty with the jugulars into the Cuvierian sinus of the auricle of the heart. From the aorta are given off, at different parts of the body, a great number of small arteries, which are distributed to different parts of the body. In most fish and other vertebrata, the principal arteries thus given off in the embryo are the omphalo-meseraic arteries, which pass to and over the vitellus. In the Trout and Salmon there are two of these arteries, one, the most anterior, passing directly to the yolk, a second passing along the upper side of the intestine, supplying it with blood, and returning along its ventral side, to unite with the first omphalo-meseraic artery, and then, dividing into innumerable capillaries, pass over the vitellus, to be gathered together once more, and empty their contents through the omphalo-meseraic vein or veins—sometimes there is only one, sometimes two—into the Cuvierian sinus of the auricle. In the

Shad, Lake-Herring and White-fish there is only one of these arteries. In the Smelt there is none at all, since the yolk, by this time, is entirely absorbed, undoubtedly by absorption from cell to cell, without any assistance from the blood-vessels. Fig. 4, Pl. V, shows the yolk nearly absorbed, with the liver just forming at its posterior dorsal extremity. There is no blood flowing in any part of the young Smelt at this time. When the yolk and liver become as shown in Figs. 6 and 7, Pl. V, with the central spherical mass of the yolk of a decided yellow color, and so as to be barely discernible in the living fish, we can discover the 1st circulation of the blood. The other arteries given off from the aorta are distributed along the entire length of the body. As a rule, an artery is given off to supply each vertebral segment of the body, and to each of the pectoral fins. In the tail, the aorta is at first, as already stated, simply folded upon itself; soon, however, it divides into three branches, or more properly, a connection is made between the aorta and vena cava, at a short distance from the posterior extremity of the vessels, thus making a little shorter passage for the blood; and through this new passage most of the blood flows. Where this connection link is made from the aorta, a third vessel is formed, which passes upward and forward around the notochord, near its posterior end. The branch which was the original end fold of the aorta, still persists and supplies blood to the end of the notochord. The connecting-link branch, through which most of the blood now returns to the heart, gradually lengthens, so as to become as long as the primitive branch, is divided up into capillaries, one of which is sent to each ray of the tail, and becomes, in fact, *the* caudal artery. It is at the branching of these three arteries that the so called "caudal heart" of fishes is found. It is no heart at all, and there are no pulsations there, except such as are seen in all arteries, and due to the same cause. It is true there is a slight enlargement at this point, and sometimes the enlargement is considerable, but it is due

wholly to the sudden stoppage of the rapid on-rush of the blood driven from the heart, by the branching of the aorta and the sudden bending upon itself of the main return branch. The blood cannot escape fast enough into the smaller vessels and around the curve, and so is piled up at this point,* stretching the elastic walls of the aorta into quite a cavity, and, by forming a sort of cushion for the impulses of the heart, magnifies the beat; and this, together with the natural rebound of elastic walls when tightly stretched and then released, gives the "caudal heart."

In Trout and Salmon, and especially in Lake-Herring, there might with equal justice be said to be a "yolk heart," since where the omphalo-meseraic artery, or arteries, pass from the aorta, there are dilatations of the vessels, and the same "beating" appearance is seen. In the head a great many small arteries are sent off, which ramify through the brain and surrounding tissue. The position of these new vessels, and of the branchial vessels, after they pass into the head tissues, is continually changing and approximating toward a central vessel on the ventral surface of the brain, which is to unite with the body aorta, and form a connection between all the branchial vessels and the aorta, so that by far the greater portion of the blood shall make the complete circuit of the body before returning to the heart. I was not able to see this change in the Smelt, on account of the impossibility of keeping the young fry alive. They would not feed. My observations upon the development of the Smelt, therefore, end at this point. Much of the embryology of this paper requires to be further authenticated by examination and sections. This work I hope to perform at no distant day.

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* Quære. Does this offer any suggestion as to the original formation of a heart?

Is a heart homologically simply an improvised dilatation, for retarded blood, of a branched or bending vessel, and a dilatation in which the rythmical pulsations, originally impressed upon it from without, have become inherited, and are now originated and perpetuated by it through a force which has become a part of itself?

VARIATION IN THE SMELT.

While at work upon the embryology of the Smelt I was constantly being reminded by the fishermen that the Raritan river Smelt was entirely different from that of New England, and by inquiring I found the difference to be in size, flavor, and the transparency of the skull. The fishermen maintained very strongly that the New England Smelt was a larger, coarser fish than theirs; that in the New England Smelt no "old man's face" could be seen through the skull; and that for the table the Raritan river fish was so much superior that there could hardly be any comparison between them. They also claimed two species of Smelt for the Raritan river: one, the common *frost-fish*—the other, the *silversides*. This latter fish, according to them, never grows to a greater length than 3 or 4 inches, and the silvery sides, and silvery reflections generally, are much *more silvery* than in the *frost-fish*. In other words, the *frost-fish* is a larger and less brilliantly tinted fish than little *Mr. Silversides*. The *frost-fish* is often found from 8 to 12 inches in length. Persons acquainted with the Raritan river Smelt, only as a table luxury, were of the same opinion as the fishermen in regard to its being a distinct species, and I was desired to investigate the subject.

In order to do this at all satisfactorily, I have found it necessary to go pretty thoroughly through the literature of the subject, both in regard to the European Smelt, (*Osmerus eperlanus*), Rond., and the American Smelt, (*O. viridescens*), Lesueur; and in order to give a just idea of the variation, it will be necessary to follow, to a certain extent, the bibliography and natural history of the subject in this paper. I shall treat—*first*, of the American Smelt; *second*, of the European Smelt; *third*, compare the two; and, *fourth*, give a fairly complete bibliography of both. While at New

Brunswick, with every day many of the Raritan river Smelt at hand, I sent to Mr. Blackford, the well-known fish-dealer of Fulton Market, New York, for some male and female Smelts, which he could guarantee me as having come from New England waters, and being genuine New England Smelt, the *O. viridescens* of Lesueur. With that kindness which he always shows towards scientific workers, he sent me some very fine fresh specimens of Smelts, which he guaranteed as having been caught in Little Narragansette Bay, R. I. With these specimens before me, placed alongside of fresh specimens from the Raritan river, I was able to compare them with the greatest nicety. There were certain slight differences. The color along the back and above the lateral line was of a slightly lighter shade of green in the New England Smelt than in that of the Raritan; the first fin-ray in each fin in the Raritan fish was darker than the rest of the fin; while in the New England fish the fins were nearly uniform in color. In length, the Raritan Smelt would probably average 5 inches; the specimens of the New England Smelt which I had, averaged about 7 inches. The Commission, however, had Raritan Smelt in their reservoir eight inches or more in length, and they have been taken in the Raritan of a length of thirteen inches, according to the fishermen. And in regard to the Northern Smelt, Mr. Ch. Lanman, in the United States Fish Commissioners' Report for 1872–3, page 224, says that the average size of Smelt in Eastern Maine and New Brunswick is only five or six inches. The shape of the body, and the length of body and head, compared with each other, in the two kinds, were nearly identical. The number of rays were the same in each, and were as follows:

B. 8; D. 11; P. 11; V. 8; A. 15; C. 19+.

The scales were the same in shape, with similar concentric markings, of proportional size and nearly transparent. Fig. 11 a, b, Pl. V. The teeth were alike, and consisted of a row of fine, closely-set teeth the entire length of the max-

illaries; one or two pairs of vomerine fangs; two rows upon the tongue, of which the anterior four or five teeth were fang-like, and generally with a single fang at the extremity of the tongue; two rows of small teeth upon the anterior portion of the mandible, of which the inner were the larger; the outer row of mandibular teeth extended laterally upon the mandibles, but were more scattered and *larger* than anterior, and also larger than those in the inner anterior row. There were also rows of palatine and pterygoid teeth, but they were all small.

All the teeth were recurved to a greater or less extent. See Fig's 8, 9 and 12, Pl. V. The viscera was similar, and the number of pyloric cæca five in each. The head in the two fish showed greater variation. In the New England Smelt it was fuller: the lower jaw did not protrude so far beyond the upper, and the gape of the mouth was not as great vertically. The difference in the fullness of the head and the rounder snout and less prominent mandible in the New England fish, are shown in Fig's 13 and 16, Pl. V. The great gape of mouth in the Raritan Smelt is shown in Fig. 9, Pl. V. The general shape of the head in the Raritan Smelt, Fig 8, Pl. V, is more delicate and pointed than in the other, Fig. 12, Pl. V; the top of the head, back from the eyes, is slightly flattened, from whence there is a rise to the dorsal contour line of the body. The delicacy of the head is due to the slight contraction of the sides of the head in the region of the eyes, Fig. 13, Pl. V, and the protrusion of the jaws thus narrowed into a more slender snout.

The lateral line in each begins at the dorsal extremity of the gill-opening, curves ventrally and posteriorly for a short distance, then passes in a straight line to the tail, near its center. The differences upon which we have, then, to form two species of them, are, *first*, a higher coloration of the back and of the first fin-rays in one than in the other; *second*, in size, and *third*, in the shape of the head. As regards the *frost-fish* and *silversides*, upon placing side by

side such specimens as were acknowledged by the fishermen to be types of the two kinds, no differences could be detected by the fishermen themselves, even in the brilliancy of the silver markings; and when convinced of this, they said, "well, these never grow any larger," referring to the *silversides*. If *size*, and perhaps a slight variation in coloration, can determine species, then we have at least *three* species of Smelt in this country.

Up to 1817, the American Smelt was considered to be identical with that of Europe. In December, 1814, Mr. Sam'l L. Mitchell read before the Literary and Philosophical Society of New York, a paper upon the fishes inhabiting the waters of the State In 1815 this paper was published in Vol. I. of the Transactions of the Society. In this paper he says of the Smelt, page 435: "Smelt, (Salmo eperlanus,) bluish silvery salmon, with transparent head and 17 rays in the anal fin. This fish is occasionally brough to the New York market, but he is not a steady visitor.

I have eaten him in fine style at Newark, whither he was brought from the Passaic river."

In 1817, M. Lesueur in Vol. I., Journal of the Academy of Natural Science, Philadelphia, page 230, describes the American Smelt as a new species, *Osmerus viridescens*. His description is as follows: "*Maxillaries* denticulated in their whole length; mandibles very wide and doubly carinated lengthwise in the middle; dorsal fin higher than wide, its origin corresponding with that of the ventrals; *head* and *back* of a fine golden green, as far as the lateral line; *pectorals*, *abdominals* and the rest of the body, silver-white; air bladder, fusiform, swoln at the middle; *body*, long, sub-compressed and sub-transparent; *back*, straight, a little elevated; *lateral line*, faint, blending the green color of the back with the white of the sides and abdomen; *lower jaw*, somewhat longer than the upper, recurved, opening prolonged as far as the eyes; teeth, strong, cylindrical, long and crooked, three at the tongue very strong, one of which

is at its extremity; *pectorals*, large; *anal*, wide in front, narrow back and slightly notched; *caudal*, forked, with acute lobes; *adipose fin*, a little bent and terminating in a point; *eyes*, orbicular, iris white and brown, pupil black; *scales* equal, rhomboidal. Length, about ten inches.

Taken with the line from Boston to Newport. Good for food. B. 8; P. 14–16; D. 11; V. 9; A. 15; C. $19\frac{8}{8}$.

We believe this to be a new species, and have called it *viridescens*, from the green color of its back." In February, 1818, in the 2d Volume of the American Monthly Magazine and Critical Review, New York, page 248, Mr. Mitchell says again in regard to the Smelt: " * * * * * The specimens before me were examined on March 7th, 1816, when the color of the back was pale. They were taken near New London; they are found in various other waters around New York. *It is, beyond a doubt, the Smelt of the European naturalists.* There have been no Smelts in our market for several years until now. The anal fin is regularly distinguished for possessing seventeen rays." The Italics above are mine.

In 1833, Mr. J. V. C. Smith, in his Natural History of the Fishes of Massachusetts, published at Boston, says, page 147:

"The Smelt, *O. eperlanus*, of Massachusetts, resembles that of Europe, but still there is a variation in the number of rays in the fins. At the South, there is a variety called *menidia*, which has twenty-four rays in the anal fin."

Dr. J. Richardson, Fauna Boreali Americana, London, 1836, Part III, page 185, notices M. Le Sueur's claim of a new species in the American Smelt, under the name of *O. viridescens*, but considers that, as Cuvier was well acquainted with Le Sueur's papers, and did not consider the differences sufficient to establish a new species, he will retain the name given in the Regne Animal, i. e. *eperlanus*.

He gives the rays as B. 7–8; P. 14; D. 10–0; V. 8; A. 16; C. $19\frac{10}{10}$; and in a note says that the last anal ray is

often divided to the base, and hence, to a cursory glance, would indicate seventeen anal rays. Mr. D. H. Storer, in his Report upon the Fishes of Massachusetts, Boston, 1839, p. 102, after describing the Smelt, says: "In the 1st Volume of the Journal of the Academy of Natural Science, of Philadelphia, Le Sueur describes this as a new species, under the name of "*viridescens*."

Cuvier does not acknowledge this to be distinct from the European species, and therefore Artedi's name has the priority." In 1842, Mr. James De Kay, in Natural History of New York, Zoology, Part I, page 243, admits Lesueur's new species, as *O. viridescens*. He gives the length of the American Smelt at six to twelve inches; and makes Cuvier the author of the genus *Osmerus*, instead of Artedi, to whom belongs whatever of credit there may be in the origination of this generic name. His description otherwise coincides with that of Storer. In 1845, Storer reconsidered his account of the Smelt, and in Memoirs American Academy of Arts and Sciences, New Series, Volume II, Cambridge, 1846, page 450, says: "I wrote Mr. Yarrel upon the subject, who kindly sent me several specimens of the *O. eperlanus*. Upon examination, they differ from our species, and with specimens of our own and foreign fish before me, the difference was quite perceptible. Our fish will, then, of course, bear Lesueur's name of *O. viridescens*.

Mr. Yarrel writes me, respecting the two species, 'our fish is considerably lighter in color, particularly upon the back, and on the dorsal and caudal fins. The double series of transverse lines on the sides in our fish are wider apart, and the lozenge-shaped spaces are in every sense larger. Our fish is deeper for the same length than yours; the body is thicker, but the head, particularly the parts about the jaws, is narrower.

Our fish has the gape opening more fully vertically. The eye in our fish is smaller; the preopercle deeper; and its posterior edge more truly forming a vertical line.'"

Had Mr. Yarrel been describing the differences between the New England and the Raritan Smelt, he could hardly have expressed them more accurately. In Volume VI, Memoirs of same Society, p. 327, Mr. Storer adds these remarks: "The upper part of the abdomen, beneath the lateral line, presents the appearance of a satin band the entire length of the body; the upper edge of this band *is of a beautiful violet tint.* The fin rays are D. 11; P. 14; V. 9; A. 15; C. 19."

The italics above are mine.

In 1848 M. A. Valenciennes, in Histoire Naturelle Des Poissons, Par Cuvier et Valenciennes, Paris, 1848, admits the new species as the Eperlan of New York, *O. viridescens* Lesueur. He gives the rays as follows; D. 11; A. 16; P. 12; V. 8. He says, page 283, vol. XXI,* after giving the characters which distinguish the two species, which differences are nearly as given by Yarrel, already cited, "We have received a large number of specimens of this species from the New York market, through the kindness of M. Milbert. Mitchill has considered it identical with the Eperlan of Europe, under the name of *Salmo eperlanus*, or Smelt; but one would imagine that M. Lesueur, born at Havre, and consequently at the mouth of the Seine, might have easily distinguished at the first glance a fish which he had known from childhood. The green and olive color of this species struck this naturalist, who described it in the Jour. of the Acad. of Nat. Sci. of Phil. under the name of *O. viridescens.*" In Jan., 1861, in a Catalogue of the Fishes of the Eastern Coast of North America, published as an Appendix

*Nous en avons reçu un grand nombre d'exemplaires du marché de New York, par les soins de M. Milbert.

Mitchill l'a confondue avec l'Eperlan d'Europe sous le nom de *Salmo eperlanus* ou de Smelt; mais on conçoit que M. Lesueur, né au Hâvre, par conséquent à l'embouchure de la Seine, ait facilement distingué à la première vue, un poisson qu'il connaissait depuis l'enfance. La couleur verte et olivâtre de cette espèce a frappé ce naturaliste, qui l'a décrite dans le Journal de l'Academie des Sciences de Phil., sous le nom d'*Osmerus viridescens*.

to the Proc. Acad. Nat. Sci. Phil., 1861, at page 53, Mr. Th. N. Gill gave the name of *mordax* to the American Smelt, without giving any reference as having described it as a new species. His only reference is Storer. Syn. Fishes N. A., page 197, where *O. viridescens* is given as its specific name. In the same volume of the Proc , page 58, Mr. Thaddeus Norris claims a new species in the Smelt of the Raritan and Delaware rivers. His description was re-printed in the American Anglers' Book, Phil., 1865, page 263.

He says: "The points of difference between this and the *O. viridescens* are, the more southern habitat of the new species, its smaller and more uniform size, and the distinct roseate purple of the streak above the lateral line. *O. viridescens*, the Northern Smelt, attains the length of twelve inches. I have seen the new species here described in quantities at New Brunswick, N. J., but never exceeding six and a half inches, exclusive of caudal." In his American Fish Culture, Philadelphia, 1868, page 202, he calls the Raritan and Delaware Smelt, *O. Sergeantii*, thus taking it for granted that it *was* a new species. In the Catalogue of Fishes, London, 1866, volume VI, pages 167-8, Dr. Guenther gives the name of *O. viridescens* to the American Smelt, and says, "Scarcely distinct from *O. eperlanus*, but with a little smaller scales; the number of transverse series above the lateral line being sixty-six. The posterior mandibular teeth not larger than the anterior ones." In the United States Fish Commission Report for 1871-2, page 810, Mr. Gill classes the Smelt as *O. mordax*, (Mitch). But Mitchill gives no such name to the Smelt. In answer to my inquiry upon this point, Mr. Gill writes to Mr. Ferguson, under date of December 9th, 1877: "The species was first described by Mitchill in the Trans. Lit. and Phil. Soc., N. Y , volume I, page 416, under the name of *Atherina mordax*. * * The species is not badly described, although, of course, Mitchill made quite a mistake in its systematic position, being deceived by a certain similarity in aspect and color between

that species and the true *Atherinæ;* the name must, however, be adopted, and the species called *Osmerus mordax.*" As Mr. Gill says, the description is not bad as applied to the Smelt, but it would apply equally as well to stray specimens of the Capelin, *Mallotus villosus*, or Argentine, *Argentina*—. DeKay Nat. Hist. of New York, 1842, Zoology, part I, page 143, says upon this point: "With regard to the *Atherina mordax*, or large Silver-sides of Mitchill there is more difficulty," (i. e., than homologizing *A. viridescens* with *A. menidia*). "From its dental armature and adipose dorsal, it cannot be arranged in this family. In his "report in part," he states that 'it may be *A. Brownii;* if it be so considered, we shall know it better for the future.' I am not acquainted with the species referred to, but have no doubt that the *mordax* is the true *Osmerus* of the family *Salmonidea*. I am disposed to believe that my late venerable friend has, by mistake, applied the description of *O. eperlanus* this species," (*A. menidia*).

If, therefore, a person does a thing when he does not intend it at all, that thing must be binding upon all who come after him. And because Mr. Mitchill wrote a description of *some kind* of a fish, and attached the specific name of *mordax* to it, therefore, because *that kind* of fish is not known exactly, and because the description applies fairly to the Smelt, the Smelt must be known as *mordax*. Mr. DeKay did not think so; Mr. Guenther did not think so; accordingly, neither of them have given to the Smelt the synonym of *mordax*.

But what is much more to the point and certain, is that Mitchill did not intend this description to apply to the American Smelt. He was acquainted with the Smelt, and in this same report, upon a previous page, (435,) he describes it as *Salmo eperlanus;* and again, at a later date, February, 1818, in American Monthly Magazine and Critical Review, page 248, he says: "It is, beyond a doubt, *the Smelt of the European naturalists.*" We can, then, adopt

one of three methods of settling the question: to consider, as with De Kay, that it was a mistake in describing a specimen of *A. menidia;* that it was a stray female Capelin, or a strange form of Argentine; or that it was some fish which we cannot identify. To whichever conclusion we may arrive, it is equally evident that Mr. Mitchill did not intend that the American Smelt should be erected into a new species; hence, *mordax* ought not to be used in connection with it. I hardly think that the scientific claim for priority in nomenclature has arrived, as yet, at that pass that things not intended, and not desired, shall become *faits accomplis*.

The change in synonymy of the American Smelt, up to present time, has been, *Salmo eperlanus*, Mitchill; *Osmerus eperlanus*, Smith; *O. viridescens*, Lesueur; *O. mordax*, Gill; *O. Sergeantti*, Norris. Mr. Lesueur made a species of the American Smelt as distinct from the European, almost solely upon a difference in *color*.

Mr. Norris made a species of the Raritan and Delaware Smelt, upon *color* and *size*. Now, to please the fishermen, we ought to create a new species, on account of *size*, to indicate their little *Mr. Silversides*. We will then have, on the eastern coast of the United States, *O. viridescens*, Lesueur, for the northern fish; *O. Sergeantti*, Norris, and *O. argenteus*, Rice, for the southern fish. But it is best to bear in mind that in the Smelt we find a range of color from light green to dark green upon the back, and dull or more polished silvery-sides, with or without a roseate tint on or above the lateral line; in length, a range from fry up to ten or twelve inches; in rays, B. 7–8; D. 10–11; P. 11–16; V. 8–9; A. 15–17; C. 19+. And these ranges occur in fish from each and every place which claims a new or different species.

European Smelt.

The Smelt of Europe was known very early in France as the Eperlan. To this name Rondeletius or Rondelet gave a Latin termination, calling it *eperlanus*

Willoughby named it *Eperlanus Rondeletii*.

Gronovius changed its generic termination by putting it among the *Salmonidæ*, in the genus *Salmo*. And Linnæus transferred Willoughby's generic term, and attached it to the generic name of Gronovius, and the Smelt became known to scientific persons, for a long time, as *Salmo eperlanus*. Artedi then instituted the genus *Osmerus*, and Lacepede placed the Smelt in this genus, as *O eperlanus*, which name it holds up to the present time. Scientifically, the name would be *Osmerus*, (Artedi), *eperlanus*, (Rondel.), Lacepede. Other names have been given it by persons who supposed they were describing new species of Smelts; these will appear in the bibliography. A very excellent description of the European Smelt, or Eperlan, was given by M. Marc Elieser Bloch in his Ichtyologie, Berlin, 1785.

Very little has been added to the description of the Eperlan since then, except to show that Bloch's two species were but old and young of the same form. I give his description, and it may be well to compare it carefully with the descriptions already given of the American forms. I quote from Castel's edition of Bloch, Paris, 1809, Volume VI, page 29.*

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* L'Eperlan, *Salmo eperlanus.*

On reconnoît ce poisson à sa mâchoire inférieure qui est avancée, et aux dix-sept rayons de la nageoire de l'anus. On trouve sept rayons a la membrane des ouies, onze aux nageoires de la poitrine, huit à celle du ventre, dix-neuf à celle de la queue, et onze a celle du dos.

L. Eperlan a le corps demi-transparent; il brille d'un vif éclat, et presente successivement le vert, le bleu et le blanc dont il est orné. Le corps est rond, et devient plus mince en avançant vers la queue et vers la tête; de sorte qu'il ressemble assez à un fuseau. La tête est petite, et finit en pointe émoussée. Les yeux sont grands et ronds, la prunelle noire, et l'iris argen-

"The Eperlan, *Salmo Eperlanus*.

This little fish may be recognized by its protruding mandible and the seventeen rays in its anal fin. The other rays are B. 7 ; P. 11 ; V. 8 ; D. 11 ; C. 19.

The Eperlan has a semi-transparent body, which shines with great brilliancy, and presents successively tints of green, blue and white, with which it is adorned. The body is round, and becomes smaller towards the head and the tail, so that it quite resembles a spindle. The head is small, and ends bluntly. The eyes are large and round ; the pupil black, and the iris silvery, shading into blue. The lower jaw is recurved ; the upper straight. Both are, as well as the palate, provided with small inwardly curving teeth. Four or five teeth are also found upon the tongue. Its body, which is generally only two or three inches long, is covered with small silvery scales, which are easily detached. This fish is so transparent, that one can distinguish in the head the divisions of the brain, and count in the body the vertebræ and the ribs. The back is round and gray ; upon the sides there is a silvery depth, upon which one sees a changeful mingling of green and blue tints. The belly is round

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tin tirant sur le bleu. La mâchoire inférieure est recourbée ; la supérieure est droite. Toutes deux sont, ainsi que le palais, pourvues de petites dents recourbées en dedans. On voit aussi quatre à cinq dents sur la langue. Son corps, qui n'a pas ordinairement plus de deux ou trois pouces de long, est convert d'écailles minces, argentines, qui se détachent aisément.

Ce poisson est si transparent, qu'on peut distinguer dans la tête les parties du cerveau, et compter dans le corps les vertébres et les côtes. Le dos est rond et gris ; sur les côtes, il a un fond argentine, sur lequel on voit une couleur changeante vert et bleu, ce qui forme un mélange changeant. Le ventre est rond, blanc tirant sur le rouge. Si la couleur qu'il offre aux yeux est agréable, l'odeur que son corps exhale ne l'est point du tout. Toutes les nageoires sont grises ; celle de la queue est fourchue. La nageoire adipeuse est placée vis-à-vis de la nageoire de l'anus, et la dorsale est au milieu du corps. * * * Comme la chair de ce poisson n'est pas facile à digérer, on ne sauroit en conseiller l'usage aux personnes foibles et valétudinaires.

and white, shading into red. If the color which it offers to the eye is agreeable, the odor which its body exhales is not so at all. All the fins are gray; that of the tail is forked. The adipose fin is placed opposite the anal, and the dorsal is in the middle of the body." He adds, a little further on, "as the flesh of this fish is not easy to digest, one should not advise its use to feeble persons or valetudinarians." He considers this a fresh water fish, and separated it from the sea Eperlan, on account of the latter being a sea fish; its larger size, being from ten to twelve inches in length; and its stronger odor. They have since been found to be but young and old of the same species.

In Rees' Cyclopedia, 1st American Edition, Vol. XXXII, Article Salmo, B. *eperlanus*, we find: "Of this species there appears to be two varieties, one not exceeding the length of three or four inches; the other arriving at the general length of six, eight, and sometimes even to twelve or thirteen inches. * * * The skin is thin, and the whole body—but particularly the head—is semi-transparent; the color of the back is whitish, with a cast of green, beneath which it is varied with blue, and then succeeds the beautiful silvery gloss of the abdomen. * * In front of the upper jaw are four large teeth." M. Valenciennes, in Histoire Naturelle Des Poissons, Par Cuvier et Valenciennes, Paris, 1848, Tome XXI, page 272, gives the rays as follows: B. 8; D. 11; A. 16; V. 8; P. 11; C. 25.

At page 279, he adds:† "The color of the Eperlan varies according to the depth. Noel de la Moriniere has already indicated these variations in color in his lit le Treatise upon

† La couleur des Eperlans varie suivant les fonds. Noel de la Morinière a déjà indiqué ces variétés de couleur dans son petit "Traité sur l'Eperlan." Les pêcheurs distinguent l'Eperlan blanc et le vert.

La chair de ceux-ci est maigre et de mauvais goût; cependent, l'Eperlan vert du Pont-de-l'Arche est d'une excellente qualité.

the Eperlan. Fishermen distinguish the white and the green Eperlan. The flesh of the white is poor and of bad taste, but the green Eperlan of the Pont-de-l'Arche is of excellent quality."

Mr. Yarrel, in the British Fishes, London, 1859, Volume I, page 298, gives the rays as, D. 11; P. 11; V. 8; A. 15; C. 19.

He gives the color of the upper part of the body as, "pale ash-green; all the lower parts, cheeks and gill-covers, brilliant silvery-white." The forms of the European Smelt, which at one time were considered to represent separate species, have thus been united into a single species, *O. eperlanus*, with a range of color, from white or light ash to green, upon the back; more or less brilliantly silvered sides and abdomen; with or without more or less of a blue or roseate blending at or above the lateral line; rays, B. 7–8; D. 11; P. 11; V. 8; A. 15–17; C. 19–25; length, fry to thirteen inches. If we add to the rays those of the fish described by Richardson, Fauna Boreali Americana, Part III, page 185, which is as likely to be a European as an American form, we will have the range of rays: B. 7–8; D. 10–11; P. 11–14; V. 8; A. 15–17; C. 19–25.

If the European forms, representing such ranges in color, rays and size, are to be considered but a single species, it is no more than right that the American forms, with almost identical ranges of color, rays and size, should also be considered but a single species, and that the differences in the head, already noticed, are due to local causes, and are of not enough importance to form specific features.

But in contrasting these ranges in the European and American forms, we are led to the conclusion that unless there are greater differences than geographical differentiations, such as have formed the varieties in the European and American fishes, they should both be considered but one species. A difference in coloration ought not to separate them, and if the chief difference is in the foreign fish having

narrower jaws and a mouth capable of farther vertical distention than our own northern form, as Mr. Yarrel claims, surely the Raritan Smelt ought to fill the bill in every particular.

Guenther, Cat. Fishes, VI, pages 167-8, has summed up the differences, and all that can be given scientifically, when he says, already quoted, "scarcely distinct from *O. eperlanus*, but with a little smaller scales; the number of transverse series above the lateral line being sixty-six. The posterior mandibular teeth *not* larger than the anterior ones." He makes the number of transverse series in the European Smelt 60-62, and says that the posterior mandibular teeth are larger than the anterior ones. I have had an opportunity of examining six specimens of Smelts from the Liverpool Free Museum, genuine *O. eperlani;* and also Smelts from all along the Eastern Coast of the United States.

I find that in specimens of *equal size* of the two forms, the scales from the same positions upon the body are either of the same *shape* and *size*, or a trifle larger in the *American fish*. The teeth are identical, and in both fish the *posterior mandibular teeth are scattered, and larger than the anterior ones.*

The transverse series I find to be as follows, in specimens from different parts of our coast, and in those from Liverpool:

	American forms.	Liverpool.
Eastport,	65	65
Lake Champlain,	65	64
Portland,	64	64
Woods Hole,	66	63
Raritan River,	62	62
Chesapeake Bay,	62	62

The fin rays in the specimens from Liverpool were D. 9; P. 11; V. 8; A. 15; C. 19.

In fact, the two forms were so similar in general appearance that if taken from the same basket they could hardly fail of being declared the same fish.

I have thus hastily and incompletely compared the two fishes, and have endeavored to give in Fig, 8, Pl. V, an accurate representation, excepting the scale series, of the Raritan river form of the Smelt.

I can arrive at no other conclusion, from seeing and examining both forms, and from knowing the differences which geographical distribution brings about, than that arrived at by Mitchill in 1818. "It is beyond a doubt *the* Smelt of the European naturalists." To it then justly belongs the name of *Osmerus* (Artedi) *eperlanus*, (Rondelet), Lacepede. I have accordingly given it this name in the preceding papers. If it is ever necessary to designate the two forms, the American form can be called *O. eperlanus var. viridescens.*

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SYNONYMY OF THE ATLANTIC SMELT.

(OSMERUS EPERLANUS).

A. European Form.

Eperlanus—Rondelet, Pars. II, page 196; Belon, De Aquat. page 288; Gesner, Aquat. page 362, Thierb. page 189; Aldrov. IV, c. 12, page 536; Jonston, II, c. 2, t. 24, f. 3; Charlet Onom. page 153, n. 3; Ray, Synop. page 66, n, 14.

Eper. Rondeletii—Willoughby, page 202, tab. N. 6, f. 4.

Spirinchus—Jonston, t. 47, f. 6; Schonov. page 70, tab. 7.

Salmo, sp.—Gronovius, Zoophy, page 122, n. 373, Mus. I. page 18, n. 49.

Salmo eperlanus—Linn. Sys. Nat. 1, page 511; Ruysch. Theat. page 78, tab. 24, figure 3; Bloch. 1, page 179, taf. 28, figure 2; Bl. Schu.

page 410 ; Donov. Brit. Fish. II, pl. 48 ; Turton, B. Fauna, page 104 ; Pall. Zoog. Ross. As. III, page 386 ; Gronov. Sys. ed. Gray, page 152.

Salmo eperlanus var. marinus—Walb. Artedi, III, page 57.

Salmo eperlano-marinus—Bloch. Ber. 1785, 1, page 128, taf. 28. f. 1.

Salmo albula—Wulff. Ichth. page 37, n. 47.

Salmo albula and eperlanus—Zueck. Mat. Alim., page 262.

Trutta, sp.—Klein, Pisc. Miss. V. page 20, n. 12, tab. 4, figures 2-4.

Osmerus, No. 1—Artedi, Gen., page 10, n. 1, Syn., page 21, n. 1 ; Spec., page 45.

Osmerus eperlanus—Lacep. V., page 229 ; Rich. F. B. A., 1836, III, page 185 ; Flem. Brit. An., page 181 ; Jenyns, Man., page 429 ; Yarrel, 2d ed. 1859, II, page 129 ; 3d ed. I, page 295 ; Cuv. et Val. 1848, XXI, page 270, pl. 620 ; Guenth. Cat. Fish. '66, VI, page 166.

S. (O). spirinchus—Pall. ——— page 387.

O. spirinchus—Cuv. et Val. XXI, page 281.

O. microdon—Cuv. et Val. XXI, page 280, pl. 621.

E. vulgaris—Gaimard, Voy. Isl. and Grœnl. Poiss., pl. 18, f. 2.

B. American Form.

Salmo eperlanus—Mitchill, Trans. Lit. and Phil. Soc. N.Y. 1815, I, page 435, Amer. Mon. Mag. and Crit. Review, New York, 1818, II, page 248.

Osmerus eperlanus—Smith. Nat. Hist. Fish. of Mass., 1833, page 147 ; Rich. Faun. Bo. Am. 1836, III, page 185 ; Storer. Fish. Mass. 1839, page 109.

Osmerus viridescens—Lesueur, Jour. Acad. Nat. Sci. Phil. 1817, 1, page 230; DeKay, Nat. Hist. New York, Zoology, Part I, page 243, Pl. 143; Storer, Mem. Amer. Acad. of Arts and Sci., new series, 1846, II, page 450, 1857, VI, page 327; Cuv. et Val. Hist. des Poiss. 1848, XXI, page 283; Jordan and Van Vleck, Pop. Key, 1874, page 83.

Osmerus, sp.—Norris, Proc. Acad. Nat. Sci. Phil. 1861, page 58, Amer. Anglers' Book, Phil. 1865, page 263, Fig.

Osmerus Sergeantti—Norris, Amer. Fish Culture, Phil 1868, page 202.

Osmerus mordax—Gill, Proc. Acad. Nat. Sci. Phil. 1861, Appen. page 53, U. S. Fish. Com'r's Rep. 1871–2, page 810; Md. Fish Com. Report, 1877; Jordan, Manual of Vertebrates, 1876, page 261.

Very respectfully,

H. J. RICE.

NOTES

UPON THE

DEVELOPMENT OF THE SHAD.

Alosa Sapidissima (?).

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SIR :—The headquarters of the Commission, for the purpose of hatching Shad spawn, had been established (May, 1877) in Carrot cove, on the Northeast river, just across the flats, east from the village of Havre de Grace, Maryland. The headquarters consisted of two large covered barges, one of which served as a lodging house for the men employed by the Commission in manipulating the spawn ; the other as an engine house, to contain the machinery used in working the hatching apparatus.

This hatching apparatus consisted of a series of cylindrical sheet-iron buckets, with wire seive bottoms, attached to arms worked vertically by an engine situated within the barge. The arms were in sets, one upon each side of the barge, and extended out from the sides of the barge and over the water, about three and one-half feet. The buckets were attached to stringers, connecting the over-hanging arms, in one or two rows on each side the barge, and as close together as they could be conveniently fastened. They were so placed that when the arms were raised to their highest point the

bottoms of the buckets would be eight or nine inches below the surface of the water. This apparatus is for use in quiet water, or where there is not sufficient current in the water to move the eggs in the ordinary floating boxes. In other words, it enables the shad-hatcher to prosecute his work quite independent of wind, wave, current and weather, and hatch his spawn at all times during the spawning season. He is not obliged to seek a current, but can make a current for himself. Shad eggs are very light, and for their best care it seems to be necessary to keep them in motion while hatching. When they are placed in the buckets, and the arms worked by the engine, thus alternately raising and lowering the buckets, a current is produced through the seive portion by the buckets, which keeps the eggs constantly in commotion. The men attached to the Commission went each evening to the different fisheries along the shore of the bay, and gathered the spawn and milt from the ripe Shad, as they were taken by the fishermen from the seines. The spawn was manipulated very much, as already described for the Smelt. It was then brought, in the pans in which it was collected, for some times three or four miles, and often over quite rough water, and deposited in the apparatus just described. Generally, all the apparatus was filled with spawn in different stages of development. These buckets were the reservoirs from which I drew my working material. It will be seen, that from the hundreds of thousands of eggs and young fry thus presented, a fine selection could be made for study. This was the case with the exception of specimens representing the changes which take place during the first hour or two, or while the eggs were being brought from the fisheries to the hatching dishes.

Of these changes I was able to get specimens at South Hadley Falls, Massachusetts, in July, at the Hatching Camp of the United States Fish Commission, through the kindness of Deputy United States Commissioner of Fisheries, James W. Milner.

A room in the sleeping barge was kindly allotted to my use. This was very soon converted into a miniature scientific laboratory, and here each lot of ova or fry was taken, examined under the microscope, drawings made of the different stages, and then the specimens were placed in picric, osmic, or chromic acid—sometimes the same age specimens were put in all three—to harden, for the purpose of cutting sections, and thus authenticating the work. The specimens were manipulated under the microscope the same as those of the Smelt, page 57, and the same oculars and objectives used.

Shad eggs are exceedingly adaptable to the use of the embryologist, on account of their convenient size and great transparency. After "rising" they become about one-eight of an inch, more or less, in diameter, and very much like round clear crystals. Impregnation seems to take away even that opaqueness which existed in the freshly laid egg, and what is of much more importance, the vitelline membrane does not become opaque afterwards, so that every process can be seen with the greatest distinctness.

Unimpregnated Ovum.

The ovum freshly taken from the Shad consists of a vitellus, composed of innumerable large and small oil globules, embodied in or surrounded by a matrix of granular, somewhat opaque, plasma, enclosed by a delicate, nearly hyaline, membrane, which at first closely embraces the vitellus, and which is folded and wrinkled in all directions. Fig. 1, Pl. VI. In the great majority of the unimpregnated ova, this vitelline membrane remains wrinkled and folded closely about the vitellus, and even when placed in water, the absorption is so slight that the membrane is barely raised from the periphery of the vitellus, and very few of the foldings become obliterated. In some, the absorption is partial, Fig.

2, Pl. VI; and in about ten per cent,* or less, of unimpregnated ova, the absorption of water is complete, and the vitelline membrane becomes completely distended. The increase in diameter of the ova by this absorption of water, and distention of the membrane, is about one-half of the fully distended ova, in some cases not quite as much as this. Shortly after the distention of the vitelline membrane, and sometimes, even when the ovum is as represented in Fig. 2, Pl. VI, the vitellus, which is floating free in the centre of the ovum, becomes changed somewhat upon one side. A gathering together of the oil-globules upon this side, and a change of their form takes place. The globules are drawn out into somewhat pear-shaped bodies, with the smaller ends directed towards a common centre, Fig. 3, Pl. VI, and over this common centre a prominence, or limb, arises, which protrudes for quite a little distance from the vitellus, Fig. 5, Pl. VI.

This limb is composed almost entirely of granular substance, with a few small oil-globules in the base, and is a shade or two less translucent than the rest of the vitellus, having acquired apparently a tint of brownish yellow. In those ova which *remain* only partially distended, no limb is formed. The contour line of the vitellus is unbroken during this entire period, or at any other period during the life of the ovum, by any glomeration from the surface or the production of any direction cells from the blastoderm. The ovum will often remain in this stage of differentiation for a day or

*Mr. C. G. Atkins, who was in attendance at the Hatching Camp of the United States Fish Commission, at South Hadley Falls, Massachusetts, during the past summer, sends me the following schedule of observations made by him upon this point:

Date.	No. of Eggs.	No. swollen.	Percentage.
July 11	306	6	.02
" 19	300	35	.11
" 31	103	9	.09
August 10	small number.	0	.00

more, when it becomes gradually opaque and disintegrates. During this period of disintegration, masses, larger or smaller, will protrude from the surface of the vitellus, and oftentimes of very fantastic shape, Fig. 10, Pl. VI. The remainder of the vitellus, during this early limbed condition, remains very much as in those ova which show no "rising" phase; i. e., with oil-globules scattered throughout a granular matrix. The unimpregnated ova which do not swell at all, and those which partially swell, but in which no "limb" is formed, disintegrate much more rapidly than those which pass through the "limbed" condition. In their disintegration there is a certain amount of glomeration, but this is not as distinct as in the others, on account of the closely investing vitelline membrane. The vitelline membrane has no micropyle, and is *apparently* without pores.

Impregnated Ovum.

The most noticeable difference, to the eye, between a pan of impregnated and one of unimpregnated ova, is in the very much greater proportion of swollen eggs in the pan to which milt has been added. This is not so noticeable, unless the impregnation has been performed by the dry method. This has a certain limit, to be sure, since the eggs are quite a little time in absorbing water, and if the ova are placed in water as soon as stripped from the fish, and within half a minute afterward the milt is added, the result will be pretty satisfactory. But the best results will be reached when the ova and milt are placed in the water simultaneously. The first changes which take place in the impregnated ova are similar to those already described in the swollen unimpregnated egg. First, a slight swelling out or distension of the vitelline membrane; then, while the distension proceeds, a gathering together of the globules to one side of the vitellus, and a drawing up of the granular plasma into a "limb" or blastodermic protuberance. Figs.

2, 3 and 5, Pl. VI. This protuberance is longer in one direction than in the other, its outline marking an oval upon the surface of the vitellus. Soon, at the shorter diameter of the "limb," a very slight line of crinkling of the tissue can be seen upon the surface, extending from one side to the other, Fig. 4, Pl. VI. The crinkled appearance very soon passes away, and the tissue beneath becomes depressed into a sharply defined groove, which extends to near the base of the "limb," and divides it into two nearly equal hemispherical lobes, Fig. 6, Pl. VI.

As soon as the groove, or segmentation furrow, has attained its greatest depth, it begins to close again, until it is only about half its former depth, in which condition it remains.

A second faint line of crinkling of the tissue can now be seen along the centre of the "limb" at right angles to the first segmentation furrow, Fig. 6, Pl. VI.

This crinkling appearance soon disappears, as in the first case, and a second segmentation furrow is formed, dividing the "limb" into four rather obtuse papillæ. From this time forward there is no regularity in the number of the segmentation furrows, or in the segmentation of the papillæ upon different portions of the "limb." Sometimes, one of the four segmental papillæ already formed will divide and form two complete papillæ before there are any signs of division in the remaining three. We thus have a form with an odd number of papillæ, Fig. 7, Pl. VI. Sometimes this segmentation will extend to one pair of papillæ, and after they are segmented and nearly ready to segment a second time the other pair or pairs will segment. Although the segmentation, as thus seen, is not a regular system of bilateral coincident divisions of the four original papillæ, and of the new divisions in their turn, since an odd number of divisions is perhaps as often seen as an even number, yet this segmentation is always accompanied by the faint crinkling line of depression in the tissue; the disappearance of

the crinkled marking; the deepening of the depression, and consequent complete division of the parts; and the partial filling up of the furrow before a new one is formed. The segmentation continues in this irregular way, until the entire "limb" has become transformed into a great number of small rounded prominences upon one side of the vitellus. The ovum is now in what is known as the "mulberry" stage, Fig. 8, Pl. VI.

Segmentation does not stop here, but continues until the side of the ovum upon which the limb was situated, has assumed nearly its original granular appearance, and is a little darker in color, because denser than the rest of the vitellus. The segmentation also extends outward from this granular portion, and affects the contiguous peripheral portion of the vitellus, until we find the blastoderm, as this portion can now very properly be called, occupying quite a good portion of the moiety of the surface of the vitellus. The segmentation has taken place more in one axis than in the other, and so we find the blastoderm oval in outline, but very much more so in proportion than was the original "limb." A depression now takes place along the longer axis of the blastoderm, Fig. 9, Pl. VI, until the blastoderm is divided into two nearly equal parts, much as was the "limb" at first, except that these last divisions do not form semi-circular, but very long, oval lobes. These lobes become thinner along the periphery, and are gradually transformed into the laminæ, which, by their folding inward and union along the median line, form the neural canal, already mentioned in connection with the Smelt, page 63. The union of the laminæ along the entire median line takes place very soon in the Shad.

The outlines of the enclosed neural canal are plainly visible, making a complete circuit of the embryo.

At one end of the canal three expansions take place, which are the three cerebral vesicles, and along the middle of the embryo two or three pairs of proto-vertabræ are seen

forming from the sides of the canal. The canal is lined throughout by a layer of exoderm, which has been folded in by the closing of the laminæ, and by the differentiation of the portions of exoderm forming the three cerebral vesicles the brain is formed, and by the differentiation of the exoderm lining the rest of the canal, the spinal cord is formed. The further transformations in the Shad are similar, with the exception of the time occupied in the transformations, to those of the embryo Smelt, which have already been described, so I will proceed no further in describing the embryology of the Shad, except to give the time at which the different transformations take place. Within half an hour after being placed in water the ova are fully distended, and within an hour the great majority of them have passed through the various stages up to that figured in Fig. 6, Pl. VI, where the "limb" is completely divided by the first segmentation furrow into two nearly equal protuberances. During the next hour or two the segmentation progresses until the "limb" has become divided into quite a number of prominent papillæ. In about four hours it has reached the "mulberry" stage; and in five to six hours the lamellæ stage, represented in Fig. 9, Pl. VI, is reached. At ten hours the laminæ have united, and the embryo appears as a darkish band, streaking the longer axis of the blastoderm. At twelve hours the head end is indicated by becoming slightly broader than the other. At fifteen hours the cerebral vesicles, and a few pairs of proto-vertabræ, can be seen. At sixteen to eighteen hours the proto-vertabræ are quite numerous, and the eyes are indicated by circular markings on the lateral walls of the middle cerebral vesicle. In twenty two hours the brain is quite plainly outlined; the ear has become depressed; the exoderm is pressing in the eye sack to form the crystalline lens; the nasal pouch is indicated by a round disk-like marking; and a tract of tissue material in the anterior region, between the embryo and yolk, intimates the heart. At twenty-three hours the crystalline lens is more

enclosed; the proto-vertabræ numerous and distinct; and the heart tubular, and beginning to pulsate. At thirty-eight hours the cerebellic fold of the brain is very distinct; the crystalline lens has become completely enclosed, but the eye, as yet, has acquired no pigment granules; the ear is beginning to close; and the branchial fissures are forming. At sixty-two hours the mouth has opened; the semi-circular canals of the ear have formed, and the ear has closed externally; and the pectoral fins have formed to a certain extent About this time, or during the third day, the young fry begin to hatch from the ova. At sixty-nine hours the visceral arches are formed, but with no vessels in them; the operculum is growing backward, toward and over the first arch; the pectoral fins are quite prominent; and the heart has become a bi-lobed affair, with the two lobes nearly in the same horizontal plane, the auricle on the left side of the embryo, the ventricle on the right, and the only evidence now of a cavity is a small connecting vacuole in the centre of their abutting sides. At eighty-eight hours everything is more mature: the yolk-sack is somewhat absorbed; and the heart has assumed its mature position, with the auricle upon the dorsal side of the ventricle. During the fourth day the first circulation, through the first and second branchial aortæ, is established; and during the fifth day vessels are formed, and blood flows through all the visceral arches. By the seventh or eighth days the vessels in the body are formed, and we have a complete systemic circulation. In speaking of the omphalo-meseraic arteries, page 75, I mentioned the Shad as having only one. This is perhaps not strictly true, since the large artery which is given off above the vitellus passes along the upper side of the intestine, returns along its lower side, passes along the dorsal side of the yolk, without giving off any branches to it, and goes directly to the heart Although it is not what an omphalo-meseraic artery is generally considered to be, that is, one which sends ramifying branches over the entire surface of the yolk, yet it, without

doubt, performs the functions of such an artery by abstracting the food-material from the yolk in passing over it; the food-materials undoubtedly being drawn for this purpose, by osmosis from cell to cell, into the upper portion of the yolk, and in contact with the vessel. The unimpregnated ova are not by any means the only ones which disintegrate and die. Too many, by far, of the impregnated ova are guilty of the same performance, and exhibit in their disintegration all those curious irregular phases, one of which is represented in Fig. 10, Pl. VI. Sometimes, instead of there being a great many ball-like protrusions, there is a single round ball, nearly as large as the vitellus; the vitellus and the ball looking very much like the two ends of a large dumb-bell, without any connecting handle. Oftentimes, after the embryo has progressed quite a little in its development, one or both ends will turn opaque, and gradually disintegrate. Sometimes ball-like protrusions proceed from the disintegrating portions, sometimes the disintegrating portions form floculent masses, floating out from the vitellus towards the vitelline membrane.

I have said that at Carrot cove, in the Chesapeake bay, the spawn was often brought for three or four miles across the bay, and often over very rough water. The rolling and pitching of the boat upon the waves, and the consequent knocking together of the ova, without doubt, had a very injurious effect upon them. If the ova in the boxes are subjected to a severe storm, or if the ova are roughly pressed upon, in manipulating them, the loss is much greater than with ova treated very gently, and kept in a steady, yet not violent, current of water, away from the reach of boisterous waves and severe rains.

If rough handling and severe peltings will injure the ova, why will not rolling and tumbling in a boat over a stormy sea? It is very possible, if not highly probable, that this cartage in boats, particularly in rough water, may be the chief cause of this disintegration in the advanced as well as

the freshly spawned ova. It is also highly probable that the methods of manipulation may have much to do with it. Often quite a time elapses, especially when following the gill nets, between the spawning of the ova and the shedding of the milt upon them. At such times the manipulation must almost necessarily be imperfect. It is, therefore, very questionable whether it would not be better upon the whole to carry all ripe fish from the nets, especially the gill-nets, to the hatching barges, before spawning or milting. This might involve the purchase of a large number of fish, but if by this means the irregular results, which so often follow the cartage of the spawn, could be avoided, and the number of young fry hatched from the ova be relied upon as being from ninety-five to ninety-eight per cent. of the whole amount of ova, instead of as now varying from fifty up to one hundred per cent., it would be much more profitable. Once at the hatching-house, the spawn could be taken care of in the most approved manner, and records kept, which would enable one to work with much more assurance that the irregularities would be eliminated. It has been by the patient and gradual working out of those things unfavorable to the development of Shad ova, that Shad hatching owes its present success. It took a longer time to attain comparative success with the Shad than with the Trout, &c., on account of the delicacy and lightness of the Shad ova; and if the Commission can, at some expense and a little pains, do away with the irregularity in the percentage of hatched fry, and yet hold to their other methods, they will have added just so much towards the literature of the Shad Hatchers' Manual, and their own success as Shad propagators.

The remaining subject to be spoken of is in regard to the temperature of the water. The development mentioned in this paper took place in water of a temperature from seventy-three to seventy-six degrees. In water of such a temperature the young Shad will, as already mentioned, hatch out during the third day. If the temperature of the water be

increased four or five degrees, or to about eighty degrees, the young fish will hatch out in about forty-eight hours. This holds good for spawn *taken* when the water is about seventy-four or seventy-five degrees in temperature But when the water gets so warm that its mean temperature is eighty degrees or over, we begin to find the female Shad full of what is called "rotten spawn," with which nothing can be done. The warm water seems to have the effect of killing the spawn in the ovaries of the female, before she has reached her spawning ground on her journey from the sea. Consequently, in Shad working, the run of fish during such warm spells are worthless, so far as propagation is concerned, and the Shad-hatcher has to wait until the water moderates in temperature, and a new immigration of Shad, fresh run from the colder water of the ocean, takes place. The only alternative, to waiting for these spells of warm water temperature to pass, and for the influx of new schools of Shad, is to begin operations earlier in the season ; take such females as have matured early ; be a little longer in hatching out the young fry, getting by this means a hardier lot, of course ; and extending operations until the increase in temperature of the water brings the females which have bad spawn.

Very respectfully,

H. J. RICE.

ADDITION

TO

LIST OF FISHES

OF MARYLAND,

PREVIOUSLY PUBLISHED.

See Reports, January 1st, 1876, and January, 1877.

Explanations and Abbreviations.

Acad. Collection signifies that specimens are in the Maryland Academy of Sciences.

Fins.—D. Dorsal, *i. e.*, on the back; sometimes two in number.

P. Pectoral; attached behind the gill-covers.

V. Ventral; attached to the lower side in front.

A. Anal; attached to the belly near the vent.

C. Caudal; the tail fin.

Baltimore, January 1st, 1878.

Maj. T. B. Ferguson,

Commissioner of Fisheries of Maryland:

Dear Sir:

During my last visit to the sea-coast of Worcester county, Md , to obtain specimens of fish for the Maryland Academy of Sciences and the Museum of Druid Hill Park, I had the pleasure to observe a "run" of Blue-fish (*Pomatomus saltatrix*). Those that go to the sea-side towards the end of October for the purpose of shooting the numerous different kinds of water-fowls, have probably seen this phenomenon, and will pronounce it a sight well worth seeing, and one not easily forgotten by the lover of nature.

Towards the middle of October the fishermen have engaged an extra crew, and have all the seines ready to be used on short notice. The northern horizon is closely watched for indications of this precious fish; one, and the most noticeable, of which is the presence of large numbers of the different kinds of gulls that hover over the fish, moving southward. Instead of following their usual mode of flight, the sea-gulls gather in compact masses over the fish, darting down continuously and striking at their prey. About the middle of the month the seines are thrown out, to make a trial for Blue-fish; but only the smaller sizes, varying from eight to twelve inches, are caught. They are fish that had remained in the neighborhood through the summer. At last, the desired moment arrives. Far away northward the ocean has changed its usual aspect, and it is evident that large shoals of fish are moving towards the station. Every one rushes to the boat, and the long seines are soon in position. The fish come nearer and nearer, much too slowly, however, for the old fishermen yonder, whom old age has prevented from entering the boat. He looks at the moving shoals in a rather suspicious manner; the excitement his face showed but a few moments ago gradually disappears; an expression of extreme disgust only too plainly takes its place, and with a vigorous kick in the yielding sand, he

turns around, expressing himself with an emphasis and clearness more forcible than polite: "*Old Wifes.*" Yes, those living masses of fishes are nothing but the Ale-wifes (*Dorosoma cepedianum*). Though of considerable value on account of their large size, they are certainly not the long-expected game, and are, therefore, not molested. These so-called "Eastern Ale-wifes," thus named because they attained their full growth along the coasts of the New England States, are now migrating southwards, and are the sure fore-runner of the Blue-fish. At last they come; the whole water is boiling and foaming with them, as they advance. Sea-trouts, Old-wifes, and other fish, in their anxiety to escape their merciless foes, run entirely out of the water, covering the whole beach with their shining and quivering bodies. Unable to reach their native element again, they die in uncounted numbers—many of them more or less mutilated by their cruel pursuers, some having lost their tail, others their head, and others the half of their bodies.

In a few short hours, sometimes even much less, one "run" of Blue-fish has passed. Others follow in shorter or longer intervals, and if they do not escape unnoticed during the night, or are not too far away from the shore to be seen by the fishermen, these people harvest a well-paying crop, though a very laborious one to gather. October 17th, October 25th, November 7th, are the dates on which, during the last three years, the first "run" of Blue-fish passed Ocean City. The average weight of one of these fish is about 14 lbs.

Many forms of fish were obtained during these trips; most of them were well-known species, already in the collection; others were known to occur in our waters, but of which no specimens had so far been preserved, while a few were entirely new to the collection. The following list contains their description.

Yours very respectfully,

OTTO LUGGER.

XIIa—GADIDÆ.

PHYCIS, Raf.

P. tenuis.

The Slender Cod.

The body of this fish is moderate in length, and is covered with small scales. Eyes of moderate size. Mouth and palate furnished with small sharp teeth; those on the vomer in an angular band. Tongue smooth. Beneath the chin a small barbel. Vent nearer the head, tail rounded. Lateral line curved upward. The fins are enveloped in a loose skin; it has two dorsal fins, the anterior composed of 11 rays; the ventrals are reduced to a single long ray, bifid at its end. The throat is internally streaked with red and purple. Back and sides brown, lighter below. Fins dark brown except the ventrals, which are whitish with red extremities. Length, 15 inches.

Fin-rays:—D. 11, 54; V. 1; P. 16; A. 44; C. 25.

Phycis tenuis, Mitchel.

A single specimen of this fish was caught in early November near Ocean city, but being kept too long by the fisherman as a curiosity, it was impossible to preserve it in the collection.

XXVIII—SCIÆNIDÆ.

OTOLITHUS.

O. nothus.

The Bastard Trout.

The height of the body is $4\frac{1}{2}$ in the total length, the length of the head $3\frac{3}{4}$. The form of this *Otolithus* differs from that of the *Cynoscion regalis* (our common sea-trout,) in being shorter and thicker in proportion, and more arched along the back;

the head, too, is smaller, the snout shorter, and the lower jaw more pointed. The eye is very large, and is less than its diameter from the snout. The nostrils are double; the posterior is larger, oval, elongated, nearly vertical, and on a plane rather below the upper margin of the eye, and at the anterior extremity of the supra-orbital ridge; the anterior is circular, and very near the posterior. The mouth is large, with thin lips; the upper jaw is very protractile, and armed with a double series of small, conical, pointed teeth; in front, and between these rows, but belonging to neither, though nearest the posterior, are two large canine teeth, conical, pointed, recurved and directed backwards. The lower jaw has a double series of minute, pointed teeth in front, while behind there is only a single row, and the teeth are larger. The tongue is large, flat, rounded and free in front. The preopercle is rounded at its angle, with a crenated margin. The opercle terminates in two minute, flattened points. The anterior dorsal fin begins behind the root of the pectoral, and has eight spinous rays, received in a sheath; the second and third being longest. The posterior has one spinous and 28 soft rays; the first very short and closely joined to the second; the scales ascend high up on its roots, and make a partial sheath. The pectoral is small, arising at the termination of the opercle. The ventral is short, but tolerably broad. The anal is short; it has one delicate spinous and nine soft rays. The caudal is moderately broad, nearly straight behind. The lateral line runs along the upper fourth of the body as far as the second dorsal, where it curves down to the median plane, and continues to the end. The whole animal is silvery white except the fins, which are more or less yellowish; the pupil is deep blue, and the iris golden gray. Total length, 12 inches.

Fin-rays:—D. 8, 1, 25; P. 16; V. 1, 5; A. 1, 9; C. 18.

O. nothus, Holbr. Ichth. S. Car., p. 134, pl. 19, fig. 1.

This is an uncommon fish, that belongs to the southern waters. Two specimens were taken with hook and line in

Spring Garden, near Baltimore. The fishermen did not know the fish, but thought they might be young California Salmon Trout.

ACAD. COLLECTION.

XXXIII—PERCIDÆ.

ENNEACANTHUS. Gill.

E. obesus.

Striped Sun-fish.

The general form of this Sun-fish is subelliptical, the head being of a perfect continuity with the dorsal and abdominal line of the body. Peduncle of the tail short. Greatest depth about the middle of the length, the caudal fin excluded. Mouth rather small, and its cleft, when shut, obliquely directed upwards. Dorsal fin composed of nine spinous and eleven soft rays, the latter being elongated, the posterior ones extending beyond the base of the caudal. The anal has three spinous and eleven soft rays, the posterior ones extending likewise beyond the base of the caudal. Caudal fin posteriorily rounded. Ventral fins inserted a little in advance of the pectorals; their tips extend beyond the anterior margin of the anal. The pectorals are subelliptical, rounded posteriorily, and extend as far back as the ventrals, i. e., to beyond the anterior margin of the anal. The scales are proportionally larger, and are disposed upon sixteen rows across the line of the greatest depth, and eight or nine rows on the peduncle of the tail. The lateral line forms a regularly arched curve from the upper angle of the opercle to beneath the posterior margin of the dorsal fin, thence almost straight, and very obsolete, to the base of the caudal. The ground color is light, transparent olive, with five or six black bands. A tinge of rose color on the posterior part of the abdomen Scales generally with a V-shaped gold marking, smaller and

more like a spot, on the peduncle of the tail. Iris reddish-brown, with a vertical bar of brown. A large and subcircular black patch is observed at the upper angle of the operculum, extending over the gill-flap, upon which a double crescent is seen; this is golden at the base, with a horizontal blue or golden line below. Length, 3 to 4 inches.

Fin-rays:—D. 9, 11; P. 11; V. 1, 5; A. 3, 11; C. 17.

Pomotis dissus, Girard Proc. Bost. Soc. Nat. Hist. V, 1854, p. 40; Baird, Smiths. Rep. IX, p. 324.

This pretty little Sun-fish is very common in the dark-colored streams of Worcester county. Though confining itself usually to the muddy creeks, it is often found in clear water, but in such case, frequents only such places where the different water-plants grow very luxuriantly.

Enneacanthus chætodon, Baird, and *E. margarotis*, Jord., occur in similar places; the little Mud-fish, *Umbra pygmæa*, (DeKay), Bean., frequents also these dark, sluggish or stagnant streams, burrowing into the mud.

Acad. Collection.

XXXIIIa—ETHEOSTOMATA, Agass.

BOLEICHTHYS.

B. crochrous.

Mud-Loving Darter.

The length from the opercle to the tip of the tail is equal to 4 heads; the greatest elevation without the dorsal fin is three-fourths of the head. This small fish has an elongated, slender and compressed body, which is thicker below than above. The head is small, short, compressed, narrow between the eyes, with a rounded and full snout, though not so broad as the occiput; it is smooth above, though covered with scales on the sides. The eye is very large, and is placed half the diameter of its orbit from the snout, and two diameters from the angle

of the opercle, with its inferior margin below the median plane of the head, and its superior at the facial outline. The posterior nostril is very near the eye, at the end of the supercciliary ridge. The mouth is small, hardly reaching to the eye; the lower jaw is nearly as long as the upper, though its teeth are received within it when the mouth is shut; both are armed, as well as the vomer and pharyngeal bones, with numerous, minute, closely set, pointed, recurved teeth. The preopercle is so rounded as to present no angle; the opercle is small, triangular, with its base before and its apex behind, and is armed with a slender, delicate spine; the interopercle and subopercle are large. The lateral line runs along the superior fourth of the body, to the end of the anterior dorsal fin, whence it gradually descends to the median plane of the tail. The anterior dorsal fin begins in a line vertical with the anterior third of the pectoral, extends to the vent, and has ten spines; the posterior is more elevated, and has eleven rays. The pectoral arises a little behind the opercle and extends to the root of the ninth dorsal spine; it is slender, and has twelve rays. The ventral begins at some distance behind the origin of the pectoral fin, but extends beyond it; it is long, slender, with one delicate spine and five soft rays. The anal begins slightly behind the origin of the posterior dorsal fin, and determines with it behind; it has ten soft rays. The caudal is long, narrow, and rounded behind. Head with greenish tints at the opercle; body above pale brown; belly white; a longitudinal row of rounded dusky spots on the sides. The second dorsal and anal fins have dusky points arranged in lines. Total length, 2 to 3 inches.

Fin-rays:—D. 10, 11; P. 12, V. 1, 5; A. 10; C. 14.

Boleosoma Barrattii, Storer.

This little fish resembles very much the "Tesselated Darter" (*Boleosoma olmstedi*, Storer) in appearance, but frequents entirely different haunts. Instead of living in clear streams with rocky beds, it is found in the dark, sluggish creeks of Worcester County, settling on the black mud found

there. It belongs to the more southern fauna, having been first described from S. Carolina and Florida.

ACAD. COLLECTION.

XXXIIIb--APHREDODERIDÆ.

APHREDODERUS.

Since but one single fish forms this family, it is well to define the characters, quoting them from Guenther.

Cleft of the mouth slightly oblique, with the lower jaw longest; eye moderate. Villiform teeth in both the jaws, on the vomer and on the palatine bones. Six branchiostegals. Infraorbital and præoperculum with spinous teeth. Scales moderate, etenoid. Dorsal with three, anal with two spines. Caudalis rounded.

A. sayanus.

The Spineless Perch.

The height of the body is 4⅓ in the total length, of which the head is one-fourth; the diameter of the eye is less than the distance from the end of the snout, and two-thirds of the distance between the eye. The body is oblong, thick and sub-compressed; the back is elevated, descending with an equal curve from the soft rays of the dorsal to the nape. From 45 to 50 scales are in a longitudinal series; they are small, rough, rounded and ciliated. The lateral line is but slightly curved, almost straight, passing near the middle of the body. The head is flattened above. A bony crest, supporting two or three spines, which are continuous with the denticulated crest of the upper margin, is on the anterior portion of the sub-orbital, so that the lower margin of the orbit is smooth, while the upper two-thirds of the margin is rough; a longitudinal furrow is formed by two crests. The

wide preopercle is finely denticulated, with rounded angle, and covered with six rows of scales. The large opercles are scaly, with a smooth margin, and with a short, robust spine near the angle. The eyes are moderately large. The nostrils double; the one near the margin of the orbit is large, the anterior one smaller and tubular. The lower jaw is longest; numerous conical incurved teeth in both jaws, upon the anterior part of the vomer, palatines and pharyngeals. The smooth tongue has a free and rounded end. The vent is placed at the angle formed by the fold of the branchial membrane. The high dorsal fin is placed in the middle third of the body; it has three spinous, and eleven nearly subequal branched rays, of which the last is somewhat smaller; the ventrals are slightly behind the base of the pectorals, and contain no spinous rays; the caudal is rounded, nearly even. Greenish olive, with a vertical spot beneath the eye. Length, 3-4½ inches.

Fin-rays:—D. 3, 11; P. 12; V. 0, 7; A. 3, 7; C. 17.

A. sayanus, Gilliams.

Scolopsis sayanus, Gilliams' Jour. Ac. Nat. Sc. Ph. IV, p. 81, pl. 3.

Aphredoderus gibbosus, Cuv. & Val. IX, p. 448, pl. 278.

" *sayanus*, DeKay, New York Fauna, Fishes, p. 35, pl. 21, fig. 62; Baird, Ninth Smith's Rep., p. 326.

This peculiar perch-like fish inhabits the fresh and brackish waters of Turner's creek, near Berlin, Worcester county. It loves dark streams with muddy bottoms, on which it settles, darting away with great vigor when disturbed. Shallow places, heated by the hot rays of the sun, form the desired resorts.

Acad. Collection.

XL.—GASTEROSTEIDÆ.

GASTEROSTEUS (L.) Brev.

G. noveboracensis.

New-York Stickleback.

This pretty little fish has a fusiform, compressed body, the sides of which are covered with a series of from 30 to 33 transverse plates. The prominent lateral line is concurrent with the back, but at about the nineteenth or twentieth lateral plate it becomes elevated into sharp, compressed spines, that form a distinct ridge along each side of the tail. The small head is covered with striate bony plates, flattened above, and sloping in a straight line from the nape. The mouth, which is slightly protractile, has a vertical aspect; the lower jaw is longest. Eyes large. Minute subequal teeth in a single row on each jaw; none elsewhere. Tail very slender. The first dorsal spine is acute, placed above the base of the pectoral, and has a broad base; it is serrated on the sides, and furnished with a membrane. The dorsal spine is long, the first ray is largest, the others gradually decrease in length to the last. Pectorals long and rounded. The place of the ventral is supplied by a single ray on each side, reaching to the posterior extremity of the pubic bone; it has a dilated base, and is distinctly toothed on its side. Under each ventral spine is a soft flexible spine. The anal fin is long, slightly emarginate, with one curved spine. Caudal fin emarginate. Bluish-gray above, silvery on the sides and beneath. Length, 2 inches.

Fin-rays:—D. 1+1+1, 12; P. 11; V. 1, 1; A. 1, 12; C. 13.

Gasterosteus noveboracensis, Cuv. & Val., IV, p. 502, pl. 98, fig. 3; DeKay, New York Faun. Fish, p. 66, pl. 6, fig. 17.

But a single specimen of this Stickleback was taken in the northern part of Sinepuxent bay, in a place where the water was but little brackish. On account of the very luxurious growth of water-plants, it was impossible to haul the fine-

meshed seines with any success; no doubt, however, that these fish build their peculiar nests in such a place. The common "Four-spined Stickleback" was here also very numerous, but choosing the more shallow water.

L. ELOPIDÆ.

ELOPS, Linn.

E. saurus.

Big-Eyed Herring, Jackmariddle, or Pounder.

The entire length, from the opercle to the tip of the caudal fin, is equal to four heads and one-eighth. Body very much elongated, sub-cylindrical, round at the back, slightly flattened at the belly, and as slightly compressed at the sides, but much more so near the tail, the head is long and thick, with the snout full and rounded; the supra-orbital ridges are elevated, and leave a deep, broad, oblong depression on the vertex, which is broadest between the eyes, and very narrow behind; the orbit of the eye is marked above with parallel ridges and depressions, directed from within outwards. The eye is very large and placed near the facial outline, with its inferior margin below the median plane of the head, and about its diameter from the snout, and two diameters and a quarter from the posterior border of the opercle; it has a thick, fleshy lid of diaphonous skin, both before and behind. The nostrils are closely approximated, and rather nearer to the eye than to the snout: the posterior is semi-lunar in shape, and much the larger; the anterior is round, and both are at the anterior extremity of the supra-orbital ridge. The mouth is very large, as the posterior extremity of the upper jaw extends behind the orbit; the lower jaw seems larger than the upper when the mouth is open, but is in fact received within it when the mouth is closed; the upper jaw has no lip, but the lower has a loose fold of skin on its posterior half; both are

armed with numerous series of minute, rasp-like teeth ; the band in the inter-maxillary is narrow, that of the superior maxillary is rather broader, and extends on the outer as well as the inner margin of the bone ; the band of the lower jaw is narrow behind, and broad before ; the vomer, the palate, the sphenoidal, and the pharyngeal bones are all furnished with similar minute teeth ; even the anterior margin of the branchial arches is rough with minute asperities. The tongue is short, round in front, and rough on its posterior part with minute teeth. The dorsal fin is single, semi-falcate, near the middle of the back ; the first ray is very short, the 4th, 5th and 6th longest ; they are placed in a scaly sheath of the integuments, which ascends for some distance, but without any adhesion. The pectoral begins under and in front of the termination of the opercle, with an elongated scale in the axilla above. The ventral is stout, and arises rather before the origin of the dorsal ; it has a supplementary plate above the rays, three-fourths as long as the fin itself, and covered with scales. The anal is short, sub-falciform. All have their roots in a sheet, like those of the dorsal fin. The caudal is long, deeply forked, with a lanceolate flattened scale both above and below its root. The scales are but slightly adherent and exceedingly thin. The lateral line at its anterior part is straight, and runs nearly along the upper third of the body, but it descends to the median plane between the pectoral and ventral fins. The head is pale green above, and white with often a roseate tint at the sides ; the body is pale silver-gray above, or with a faint greenish tint, and silvery at the sides and belly. The pupil is deep blue, and the iris silvery. Total length, 24 to 30 inches.

Fin-rays :—D. 24 ; P. 18 ; V. 15 ; A. 17 ; C. 28.

E. saurus, L. Syst. Nat. 1, p. 518 ; Bloch, Taf. 393, fig. 1 ; DeKay, New York Fauna, Fish, p. 267, pl. 41, fig. 131 ; Cuv. & Val. XIX, p. 365.

—*inermis*, Mitchell, Lit. & Phil. Trans. New York, I, p. 445.

A very large specimen of this fish was caught in the southern part of Chesapeake Bay. It is a voracious animal, that feeds on smaller fish. The flesh, both lacking firmness and flavor, is not esteemed as an article of food.

ACAD. COLLECTION.

MEGALOPS, Lac.

M. thrissoides.

Jew-fish. Tarpum.

This largest of all the Herrings has a compressed, oblong body, with a flat abdomen. The snout is obtusely conical; the mouth anterior, lower jaw prominent. The intermaxillary is short, the maxillary forms the lateral part of the mouth, and extends beyond the orbit. Between the mandibles is a narrow osseus lamella, attached to the mandibulary symphysis. The mouth is furnished with three bands of villiform teeth in the jaws, with teeth on the vomer, palatine and pterygoid bones, on the tongue and on the base of the skull. The gill-membranes are entirely separate, with numerous branchiostegals. The scales are very large and adherent. The lateral line is distinct, and runs in an almost straight line along the upper third of the body. The ventral fin is conspicuously in advance of the origin of the dorsal fin; the anal is rather longer than the dorsal. The long ray, the last of the dorsal fin, forms a very conspicuous character of this fish. The general color is beautiful silvery, darker on the back. Length, 4 feet 3 inches.

Fin-rays:—D. 17; P. 15; V. 10; A. 25; C. 30.

Megalops thrissoides.

Clupea cyprinoides, Bl. IX, p. 32, tab. 403; Lacep, V, pp. 424, 461.

Clupea thrissoides, Bl. Schn., p. 424.

— *apalike*, Lacep. V, pp. 425, 461.

— *gigantea*, Shaw, Zool. V, p. 173.

Megalops atlanticus, Cuv. & Val. XIX, p. 398.

This large fish, looking—if it was not so much more slender—like a overgrown Mud-Shad, (*Clupea thrissa*), was caught in the Chesapeake bay, near Crisfield. "Maregraw assures that it attains the length of twelve feet, and the thickness of a man. The mouth, when it is opened, is so large that the head of a man could easily enter it; it is very fat, and only the flesh of very young fish can be utilized as food."

Acad. Collection.

LXVIa—SQUATINIDÆ.

SQUATINA, Dum.

S. dumerili, Les.

Angel-fish. Shark-ray. Monk.

This peculiar fish, combining the characters of a *shark* with those of a *ray*, has a broad flattened body, which is elevated towards the pectorals. The head is wider than long, obtuse, emarginated in front between the nostrils, depressed above and between the eyes; it is bordered on each side by a white membrane. Neck rather tumid and distinct. Eyes small; orbit elevated, and furnished with blunt tubercles; similar ones above the nostrils and between the spiracles. Cheeks flat, with numerous pores. Nostrils with skinny flaps on the margin of the snout; they are on the anterior edge, above the jaws, and between the eyes; aperture vertical, and covered by a broad membrane. Spiracles behind the eyes, wide, transverse. Teeth conical, pointed and distant, in six to seven distinct series. Gill-openings rather wide, lateral, very near each other, and partly covered by the base of the pectorals. Tongue triangular, flat, not distinct, terminated by a small fleshy rounded appendage. The subtriangular pectoral fins are large, expanded in the plane of the

body, with the basal portion prolonged forwards, but not grown to the head; they have a round notch at their inner base, and curved sharp points on the upper surface of their outer margin. Abdominal fins lanceolate, straight, narrow. The two dorsal fins are triangular, subequal in size, and situated on the base of the tail. Caudal fin emarginate; lower lobe longest, both pointed. Bluish ash-gray above; beneath white. Abdomen, throat and ventral fins marked, when living, by indistinct red spots. Eyes yellowish-green; pupils black. Length: 3 to 4 feet.

Rhina squatina, Guenther Cat. VIII, p. 430.

Squalus squatina, L. Syst. Nat. I, p. 396; Brunn. Ichth. Mass., p. 5; Bl. Ausl.; Fisch. I, p. 25, tab. 116.

Squatina lævis, Cuv. Regne Anim.

— *aculeata*, Cuv. Regne Anim.

— *angelus*, Dumeril, Zool. Anal., p. 102.

— *dumerilii*, Lesueur, Jour. Ac. Nat. Sc. Phil. I, p. 225, pl. 10; DeKay, New York Fauna, Fish, p. 363, pl. 62, fig. 203.

This fish is an inhabitant of most of the temperate and tropical seas. Its curious form make it conspicuous among the many inhabitants of the ocean, that are caught late in the fall on the coast of Worcester county. The not very inviting looks of the fish are not the only reasons why fishermen dislike it. It has, to some extent, the unpleasant habits of the snapping turtle, since it can open its mouth very suddenly to an alarming extent, and not to play, either. In consequence of this biting propensity, it is called by the fishermen the "Sand-devil," and also the "Fair-maid;" the first name not without any reason, and the latter certainly not out of politeness. It is a very common fish during late October and early November, sometimes obstructing by their numbers the successful hauling of seines.

Acad. Collection.

LXVII—LAMNIDÆ.

ISUROPSIS.

I. dekayi.

The Mackerel Porbeagle.

Body cylindrical, fusiform. Head small, with a blunt pyramidal snout; the præoral portion of the latter as long as the longitudinal axis of the cleft of the mouth, tetrahidal, pointed. Angle of the mouth midway between the gill-opening and nostril. The surface of the head exhibits, under the lens, numerous minute plates, each with three parallel longitudinal elevated lines, producing a roughness when the hand is moved towards the head. On the surface of the head are four series of punctures on each side, commencing nearly opposite to the posterior margins of the orbits, dilating and extending to within about an inch of the extremity of the snout. Immediately before the eyes is a large patch of similar punctures, which extend beyond the nostrils; on the under-side of the snout is a triangular patch of similar punctures, extending to nearly the extremity; a regularly curved series of punctures from the end of the carina, concurrent with the back, and ending just anterior to the origin of the first dorsal fin. All these punctures are the apertures of mucous ducts, which are filled with a transparent jelly. Eyes moderate; nostrils doubly curved, sublateral. Gill-openings extremely wide, the width of the first being rather more than its distance from the last. Teeth of various shapes and sizes, disposed in from three to five rows. They are mostly long lanceolate, with sharp lateral edges, without basal cusps. The third tooth on each side of the upper jaw is much smaller than those next to it. The first dorsal fin, which has its origin at a very short distance from the base of the pectorals, is quadrilateral, higher than long; its upper margin is excavated, its lower angle pointed. The second dorsal fin is very small, oblong; its lower angle behind end-

ing in a prolonged point. The pectorals are falciform, the length of their lower margin being one-fourth of that of the upper. Ventrals quadrilateral; the anal fin is small, similar in shape to the second dorsal and sligtly posterior to it. The caudal fin is deeply lunate, with slightly unequal lobes. On each side of the tail is a carina, highest in the middle; a deep dentation occurs on the upper and lower sides of the tail. When first taken from the water, the color of this fish is deep green, which soon changes into a uniform dark slate, lighter beneath. Length: 5 to 10 feet.

Lamna punctata, Storer, Bost. Jour. Nat. Hist. I, 1839, p. 534, pl. 8, fig. 2; DeKay, New York Faun., Fish, p. 352, pl. 63, figs. 206 and 207.

Oxyrhina gomphodon, Mull. and Henle, p. 68, pl. 28.

Isuropsis DeKayi, Gill, Ann. Lyc. Nat. Hist. New York, VII, p. 409.

A common fish along the coast of Worcester county during the summer.

Acad. Collection.

REPORT

OF THE

COMMISSIONERS OF FISHERIES

OF

MARYLAND.

JANUARY, 1879.

ANNAPOLIS:
GEORGE COLTON, STATE PRINTER.
1879.

TABLES.

RECORD OF DISTRIBUTION OF CALIFORNIA SALMON,

Made from January 30th to December 10th, 1877, by Maryland Commission of Fisheries, under direction of T. B. Ferguson, Commissioner.

Date.	Obtained from.	Place whence taken.	NUMBER OF FISH. Originally Taken.	NUMBER OF FISH. Actually Planted.	INTRODUCTION OF FISH. Place.	Stream.	Tributary of—	Transfer in charge of—	
1877.									
Jan. 30			4,000	4,000	Near Mankton.	Gunpowder	Gunpowder	Wm. Hamlen.	.....
" 30			10,000	10,000	5 miles f'm do	Little do	do	do	.....
Feb. 1			14,000	14,000	Cherry Run.	Potomac.	Potomac	do	.....
Mar. 19			800	800	Harford Co.	Winter's Run.	Bush.	Watersville F. Club	Watersville Farmers' Club.
April 11			50	50	.....	Private pond.	.....	Alex. Rieman.	Alex. Rieman.
May 8			2,000	2,000	Near Deer Park	Youghiogheny.	Ohio.	J. H. Hines.	Senator Davis.
" 29			50	50	.....	Private ponds.	.....	Mr. Irwin.	Mr. Irwin.
" 31			50	50	.....	do	.....	H. H. Grine.	H. H. Grine.
June 4			50	50	.....	do	.....	John Wethered.	John Wethered.
Total. . .	Com. of Fish & Fisheries.	Hatching House.	31,000	31,000					From Eggs of October, 1876

Distribution of California Salmon from Eggs of October, 1877.

Nov.	19	Spencer F. Baird, U. S.	Druid Hill	30,000	29,500	Ft. Pendleton.	Potomac River	Potomac.	Wm. Hamlen	.....
	22			15,000	15,000	Piedmont.	do	do	do	.....
	22			12,000	12,000	Swantown.	Savage River.	do	do	.....
Dec.				10,000	10,000	.....	.....	.....	H. B. Miller,	Fish Commissioner of W.Va.
	5			25,000	25,000	Sir John's Run	Potomac River	Potomac	Wm. H. Hines.	.....
	7			20,000	20,000	Phœnix.	Gunpowder do	Gunpowder.	do	.....
	10			8,000	8,000	Tank Station.	Patuxent do	.....	do	.....
Total...				120000	119500					From Eggs of 1877.

RECORD OF DISTRIBUTION OF BROOK TROUT,

Made from February 19th to May 8th, 1877, by Maryland Commission of Fisheries, under direction of T. B. Ferguson, Commissioner.

Date.	No. of Fish.	To whom Given.	INTRODUCTION OF FISH.	
			Stream.	Place.
1877.				
Feb. 19	8,000	A. B. Davis.	Streams of Montgomery County.	Montgomery County.
22	1,500	McHenry Howard.	Tributary of Gunpowder river.	Baltimore County.
27	1,500	J. S. Gittings.	do do	do
27	2,000	Geo. N. Moale.	do do	do
Mar. 1	3,000	D. S. Gittings.	do do	do
2	1,500	Geo. W. Mills.	Tributary of Patuxent river.	Howard County.
2	1,000	J. M. Pearce.	Tributary of Gunpowder river.	Baltimore County.
3	1,000	Wm. Collins.	Tributary of Choptank river	Talbot County.
3	3,000	R. Norris.	Tributary of Patapsco river.	Baltimore County.
3	2,000	S. H. Tagart.	Tributary of Gwynn's Falls.	do
6	1,000	B. S. Ford.	Tributary of Chester river.	Queen Anne's County.
6	1,000	Howard Ridgeley.	Tributary of Gunpowder river.	Baltimore County.
6	1,000	Samuel Appleby.	Tributary of Patuxent river.	Howard County.
6	500	C. Ax.	Private pond.	Baltimore County.
7	1,000	G P. Whitaker.	Principio creek.	Cecil County.
8	1,500	John Donaldson.	Patapsco river.	Howard County.
8	1,000	A. G. Woodward.	Patuxent river.	Anne Arundel County.

Mar.	9	3,000	W. Polk.	Tributary of Pocomoke river.	Somerset and Worcester Counties.
	10	1,000	A. G. Cummings.	Little Morgan run.	Carroll County.
	12	3,000	A. R. McGraw.	Susquehanna river.	Cecil County.
	13	500	Louis Hammersla.	Pond.	Washington County.
	15	1,000	W. S. Kennedy.	Tributary of Chesapeake Bay.	Howard County.
	15	1,000	D. W. Taylor.	Tributary of Bush river.	Baltimore County.
	17	1,000	Jas. T. Earle.	Tributary of Corsica creek.	Queen Anne's County.
	19	1,500	Watersville Farmers' Club.	Winter's run.	Harford County.
	19	1,000	H. S. Willis.	Tributary of Deer creek.	do
	23	300	Jno. W. Hanson.	Streams of Howard County.	Brook Trout, from California, (Salmo iridia.)
April	13	750	J. Spencer.	Gunpowder river.	Baltimore County.
	17	1,000	J. B. Stake.	Pond.	Washington County.
	17	1,000	J. H. Farrow.	Shooting run.	do
	18	2,000	A. Boyle.	Deep run and Broad creek.	Harford County.
	19	200	Jesse Tyson.	Private pond.	Baltimore County.
	24	400	Mrs. Henry Wilson.	do	do
May	8	330	Senator Davis.	Pond at Deer Park.	Garrett County.
		50,480			

RECORD OF SMELT HATCHING OPERATIONS,

Conducted at New Brunswick, New Jersey, from March 3d to April 5th, 1877, on account of Maryland Fish Commission, by T. B. Ferguson, Commissioner.

Day.	Date.	Temperature of— Air. 6 A. M.	Air. 12 M.	Air. 6 P. M.	Hydrant. 6 A. M.	Hydrant. 12 M.	Hydrant. 6 P. M.	River. 6 A. M.	River. 12 M.	River. 6 P. M.	Ripe Fish. Males.	Ripe Fish. Females.	Number of Eggs obtained.	REMARKS.
	1877													
Sat.	March, 3										7	2	10,000	
Sun.	4										0	0		
Mon.	5										6	4	90,000	
Tues.	6	27	32	31	38	38	38	37	39	39	16	3	65,000	
Wed.	7	32	47	45	38	38	38	37	40	41	3	1	15,000	Sent 605 large Smelt to Salisbury, Md., by Geo. T. Finley.
Thurs.	8	36	61	59	38	39	39	38	42	49	0	0		
Fri.	9	57	43	32	39	39	39	47	49	48	2	1	25,000	
Sat.	10	24	36	25	39	39	39	41	42	41	0	0		
Sun.	11	32	44	35	39	39	39	36	42	40	12	1	30,000	
Mon.	12	35	41	43	39	40	40	38	39	40	5	2	50,000	
Tues.	13	37	39	39	39	39	39	39	40	39	0	0	Freshet.	

Wed.		14	23	38	38	44	40	40	39	39	39	0	0	Freshet.
Thurs.		15	26	36	36	39	40	39	38	40	39	7	5	150,000
Fri.		16	33	34	33	39	40	39	36	38	38	0	0	Freshet.
Sat.		17	28	30	24	39	39	40	36	36	35	0	0	do
Sun.		18	25	29	21	38	38	38	38	34	37	0	0	
Mon.		19	19	30	32	38	38	38	32	35	38	9	6	120,000
Tues.		20	29	32	31	37	38	38	32	35	38	0	0	
Wed.		21	34	49	44	38	38	38	35	36	38	0	0	Freshet.
Thurs.		22	43	46	43	38	38	39	37	38	39	0	0	
Fri.		23	42	55	62	39	42	39	40	40	42	5	15	275,000
Sat.		24	48	66	51	39	40	40	44	47	48	2	3	80,000
Sun.		25	40	39	41	40	41	45	40	42	46	0	0	
Mon.		26	41	42	43	41	41	44	41	42	43	0	0	
Tues.		27	41	51	44	41	42	43	41	41	45	2	4	90,000
Wed.		28	41	33	46	41	52	41	41	31	39	5	3	60,000
Thurs.		29	41	40	37	41	30	36	33	32	37	0	0	
Fri.		30	41	34	38	41	31	36	41	37	41	0	0	
Sat.		31	41	47	42	41	35	39	41	40	44	3	8	150,000
Sun.	April	1	41	40	44	41	46	44	41	46	45	0	0	
Mon.		2	42	53	46	41	45	45	42	44	46	3	11	200,000
Tues.		3	33	49	46	41	42	42	43	46	47			
Wed.		4	43	43	40	42	42	43	45	47	47			
Thurs.		5	41	44	41	42	43	43	45	46	46			
												87	69	1,440,000

April 21st, put young Smelt in Severn River.
" 22d, " " " Wye "
" 23d, " " " St. Michael "

A.—RECORD OF SHAD HATCHING OPERATIONS,

Conducted at "Head of the Bay," on the Chesapeake Bay, from May 4th, 1877, to June 13th, 1877, on account of United States and Maryland Commissions, by Jas. W. Milner, Deputy United States Commissioner, and T. B. Ferguson, Commissioner for State of Maryland.

Day.	Date.	TEMPERATURE OF— at 12 M. Air.	Surface Water.	Bottom.	Direction of Wind.	Condition of Weather.	Ripe Fish—Males.	Ripe Fish—Females.	Eggs obtained.	No. Fish hatched	REMARKS
Fri.	May 4	62		59	W.						Examined fish taken at Batteries above Susquehanna bridge. Milt bad.
Sat.	5	59		58	E.	Stormy.					
Sun.	6	60		56	Variable.	do.					Sunday no Seine Hauling.
Mon.	7	62		57	S.	do.	3	1			
Tues.	8	50		58	N. E.		7	11	180,000		
Wed.	9	62		56	Variable.		4	5	100,000		
Thurs.	10	56		57	N.W.		7	6	70,000		
Fri.	11	68		59	S.		4	3	25,000		
Sat.	12	62		57	S.		15	10	170,000		
Sun.	13	79		58	S						Plenty of milt. Commenced to examine the fish taken on Spesutie Island Fisheries, and on North-East river. Eggs put in tank on steamer, and taken next morning to Havre de Grace.
Mon.	14	70		66	S.				1,250,000		
Tues.	15	71		70	S.		70	45	840,000		
Wed.	16	84		79	S.		47	41	700,000	200,000	

Thurs.	May	17	83	75	72	S.		88	41	735,000	765,000	
Fri.		18	85	78	74	S. W.		68	37	660,000	350,000	Surface water hot. Loss of eggs considerable.
Sat.		19	82	78	77	S.	A severe	83	34	460,000	2,047,500	
Sun.		20	84	78	77	N. E.	— storm in	1	1	10,000	1,158,000	Heavy storm. Boxes overturned, and fish liberated.
Mon.		21	84	78	77	Variable.	the night	60	23	460,000	110,000	
Tues.		22	83	78	73	N.W.		35	18	255,000		
Wed.		23	70	75	64	N.W.		20	10	145,000		
Thurs.		24	54	69	61	N.W.	Heavy gale.	4	5	100,000	153,000	
Fri.		25	60	63	65	N.W.	do	6	8	140,000	85,000	
Sat.		26	76	64	67	Variable.	do	3	4	60 000	50,000	
Sun.		27	70	65	66	S.	Calm.	25	38	417,000	50,000	Moved scows to Spesutie narrows.
Mon.		28	69	67	66	S.		28	46	735,000	60,000	
Tues.		29	73	71	66	S.		31	23	340,000	131,000	
				3 P.M								
Wed.		30	78	73	71	S.		14	29	490.000	290,000	
Thurs		31	74	71	71	S.		7	16	332,000	661,000	
Fri.	June	1	78	74	71	S.		17	24	400,000	306,000	
				6 P.M								
Sat.		2	85	75	74	S. W.		20	27	465,000	327,000	
Sun.		3	83	77	77	S.		6	11	160,000	112,800	
Mon.		4	80	76	78	S.		6	10	145,000	360,000	
Tues		5	76	76	77	S. W.		14	13	195,000	372,000	
Wed.		6	73	75	76	Chang'ble		4	6	95,000	128,000	
Thurs.		7	78	77	75	do		7	14	225,000	116,000	
Fri.		8	84	79	79	do		6	8	125,000	156,000	
Sat.		9	77	77	77	S.		2	4	55,000	76,000	
Sun.		10	69	76	73	S W.		3	3	45,000	180,000	
Mon.		11									100,000	
Tues.		12									44,000	
Wed.		13									36,000	
								703	575	10,584,000	8,144,300	

RECORD OF OPERATIONS

Of Jas. W. Milner, Deputy U. S. Commissioner, and T. B. Ferguson, Commissioner of Maryland, conducted at "Head of the Bay," in hatching and distributing young of Shad, (alosa sapidissima,) from May 8th to June 13th, 1877.

Day.	Date.	Eggs Taken.	Fish Hatched.	Stream.	Number.	Stream.	Number.	Stream.	Number.	Stream.	Number.
Sun.	May 8–13	545,000									
M.	14	1,250,000									
T.	15	840,000									
W.	16	700,000	200,000								
T.	17	735,000	785,000	Susquehanna.	200,000						
F.	18	660,000	350,000	do	785,000						
S.	19	460,000	2,047,500	do	350,000						
Sun.	20	10,000	1,158,000			North East.	3,055,500				
M.	21	460,000	110,000	do	50,000			Mississippi.	100,000		
T.	22	255,000		do	16,000			Oconee.	100,000		
W.	23	145,000									
T.	24	100,000	153,000			do	153,000				
F.	25	140,000	85,000			do	85,000				
S.	26	60,000	50,000			do	50,000				
Sun.	27	417,000	50,000			do	50,000				
M.	28	735,000	60,000			do	60,000				
T.	29	310,000	131,000					Alabama.	75,000		
W.	30	490,000	290,000	Spesutie Narrows	46,000			Licking.	59,000		
T.	31	332,000	651,000	do	109,000	Elk.	158,000	Alabama.	100,000		
F.	June 1	400,000	306,000	do	56,000	Bohemia.	126,000	Potomac.	100,000	Upper Potomac.	150,000
S.	2	465,000	327,000	do	127,000	Sassafras.	285,000	Missouri.	100,000		

Sun.	3	160,000	112,800	Spesutie Narrows.	12,800				Missouri.	100,000	Big Black.	100,000
M.	4	145,000	360,000									
T.	5	195,000	372,000	do	100,000	Choptank.	510,000					
W.	6	95,000	128,000	do	72,000				Sacramento.	100,000		
T.	7	225,000	116,000	do	30,000				Patuxent.	160,000		
F.	8	125,000	156,000	do	50,000							
S.	9	55,000	76,000	do	20,000				Ocmulgee.	100,000		
Sun.	10	45,000	180,000	do	60,000							
M.	11		100,000	do	20,000							
T.	12		44,000	do	10,000	Nanticoke.	100,000		Wicomico.	100,000	Pocomoke.	100,000
W.	13		36,000	do	36,000				Wisconsin.	100,000	Gunpowder.	50,000
		1,058,000	8,444,300		2,134,800		1,624,500			1,283,600		400,000

PLATE I.

[NOTE.—It must be borne in mind that the figures of the following plates are more or less diagramatic, intending to bring out prominently things which are seen under the microscope very faintily, and at varying foci. The vitellus in Figs. 7, 9, 10 and 11, is either partially or not at all represented.]

Fig 1.—Unimpregnated ovum, freshly spawned, (page 58,) showing the micropyle in the center.

Fig. 2.—Profile view of unimpregnated ovum, after being in water for a few moments, (page 59.) Micropyle shows as a distinct pit.

Fig. 3—Unimpregnated ovum, after the formation of the "limb," (page 60.) This stage occurs in both unimpregnated and impregnated ova.

Fig. 4.—Impregnated ovum, showing stage preceding the "limbed" condition, (page 62.)

Fig. 5—Cluster of ova, natural size, (page 58.)

Fig. 6.—Spermatozoa, (page 61.) Enlarged 959 diameters. Three very much more enlarged.

Fig. 7—Stage just preceding the formation of the dorsal laminæ, (page 62.)

Fig. 8—Showing the mucous oval sack, with its stalk, (page 58.)

Figs. 9, 10 and 11—Segmental stages of the ova, (page 62.)

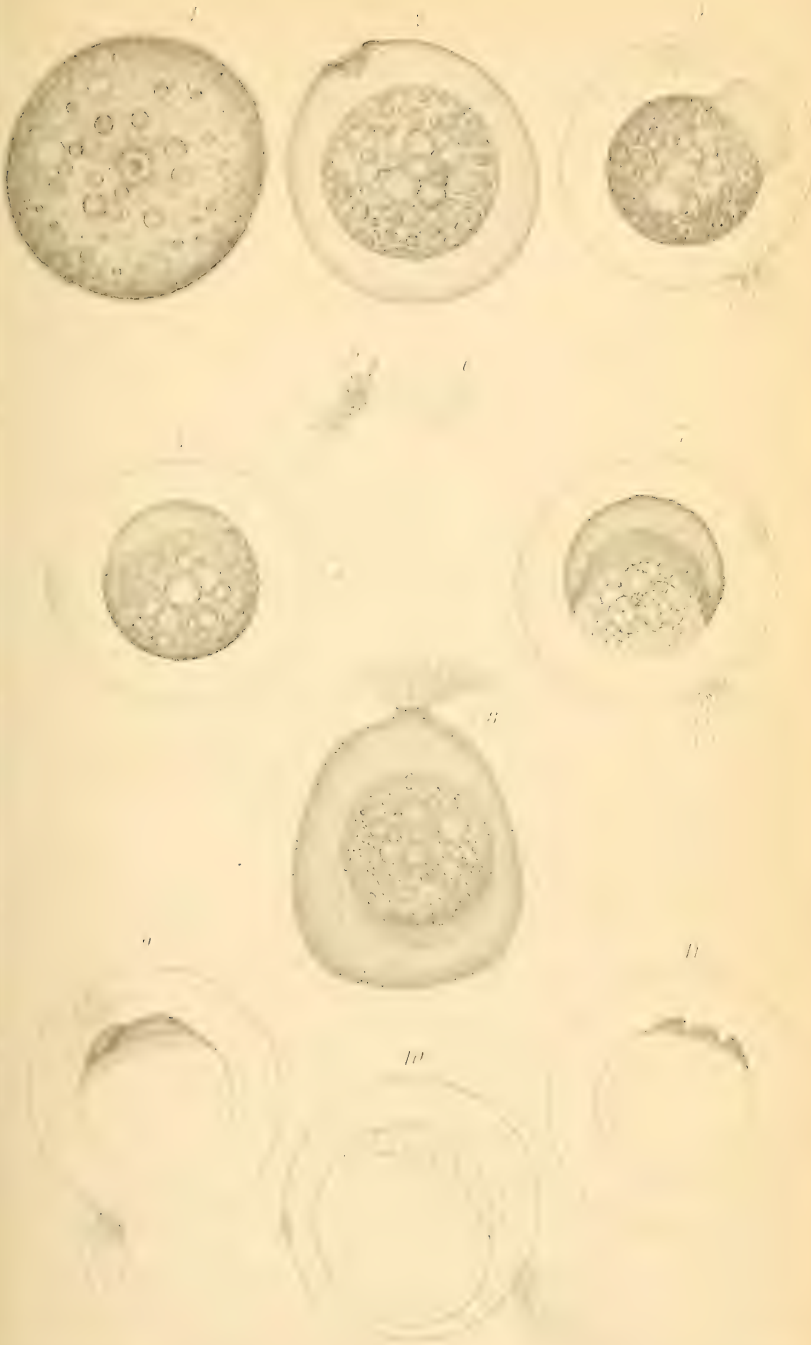


PLATE II.

[The vitellus in most of these Figs. is unrepresented. The small dots beside certain of the figures show the natural size of the specimens.]

Fig. 1—Nearly profile view of embryo, showing anterior or head enlargement, (page 64.)

Fig. 2—Nearly profile view of embryo, showing cerebral vesicles, and still open anterior end of neural canal, (page 64.)

Fig. 3—Nearly profile view of embryo, showing eye-disks, (page 64.)

Fig. 4—Profile view of embryo, showing proto-vertebræ and traces of the notochord, (page 65.)

Fig. 5—Profile view of embryo; proto-vertebræ more advanced; ear, crystalling lens, and cerebellic fold showing, (page 66.)

Fig. 6—Face view of embryo, at a little later period than shown in Fig. 5, (page 66.)

Fig. 7—Nearly profile view of embryo, showing the rows of proto-vertebræ, one on each side of the neural arch.

Fig. 8—Exoderm cells, (page 63.)

Fig. 9—Head of embryo, showing parts of brain and eye-sacks, (page 66.)

Fig. 10—Profile view of brain, much enlarged, (63.)

Fig. 11 a, b, c,—Ear at different stages of development, (pages 66–7.) The otoliths are not represented.

Fig. 12—Face view of head, at stage represented in Fig. 4.

Fig. 13 a—Top view of a portion of the dorsum of an embryo, showing proto-vertebræ on each side the neural canal.

b—Cross section of dorsum of embryo, showing cells which surround the notochord.

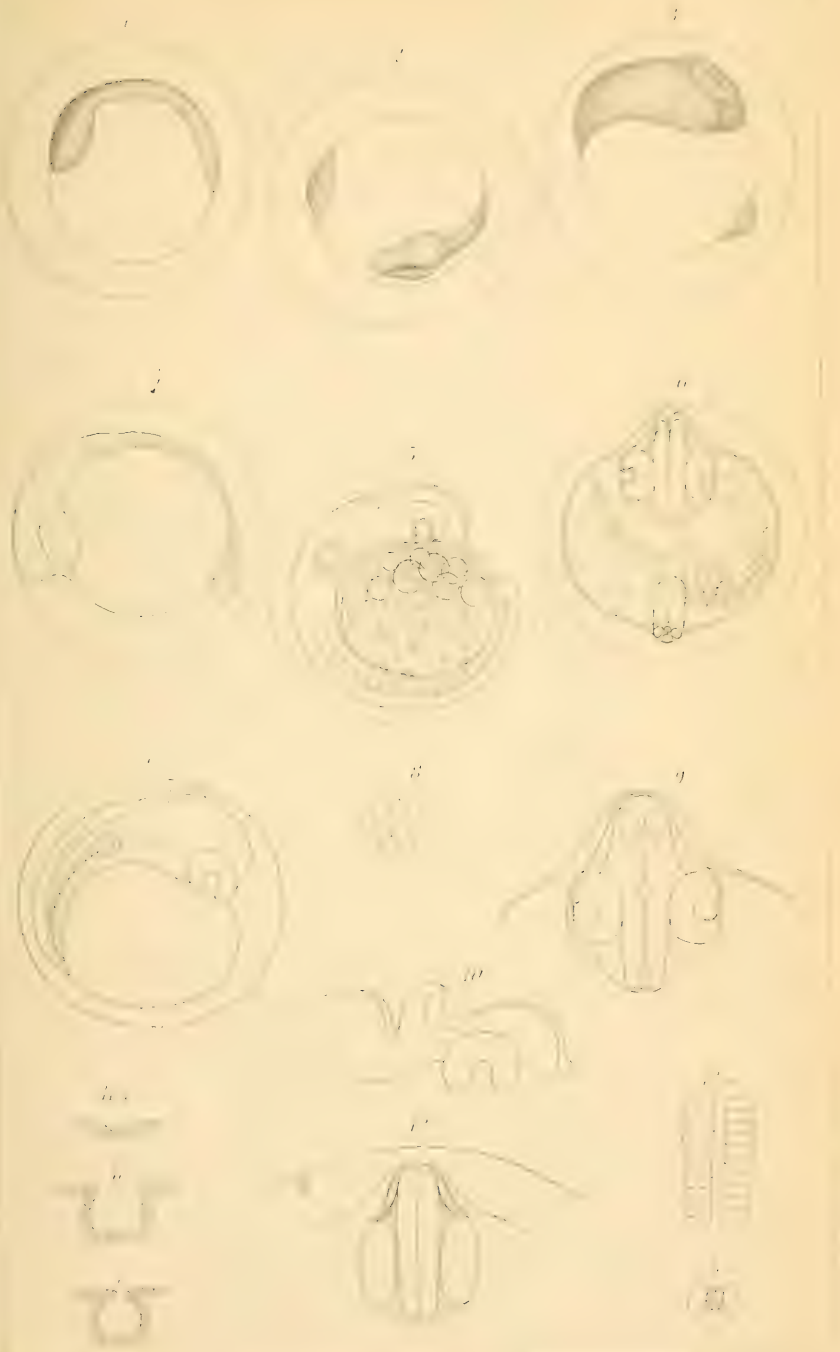


PLATE III.

[The specimens represented in this plate were removed from the ova, and were about two-sixteenths of an inch in length.]

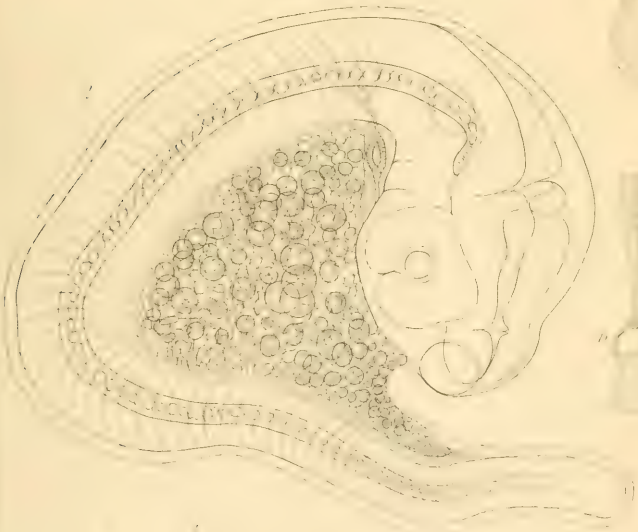
Fig. 1—Embryo before hatching; showing both ends of intestine, (page 68); the anal vacuole, (ibid); the ear with its otoliths; the heart and the branchial vesicles, (page 69.) The nasal pouch should be represented in this Fig. as a disk-like marking, just anterior to the eye, much as shown in Fig. 2.

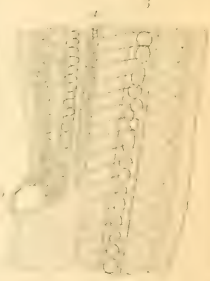
Fig. 2—Earlier stage than Fig 1. The intestine is represented by a posterior cæcum, (page 67); and the heart by a small pulsatile, pear-shaped organ, (page 67.)

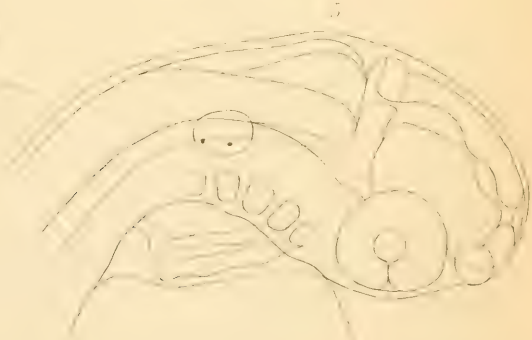
Fig. 3—Enlarged view of the anal portion of Fig. 1, (page 70.) a—Indications of blood-vessel tracts. b—Anal vacuole.

Fig. 4—Profile of portion of embryo, showing tubular condition of the heart, (page 68.)

Fig. 5—In this Fig. the heart is represented as beginning to form two portions, (page 69); and the branchial vesicles are all visible, (page 69.)







H.J Race, ad del nat.

PLATE IV.

[The specimens represented in this Plate were also taken from the ova, and were from two to three sixteenths of an inch in length.]

Fig 1—Showing the opening of the first branchial vesicle into the intestine, (page 69.)

Fig. 2—Nearly ventral view of anterior half of embryo, showing mouth opening, (page 70); and the semi-circular canals of the ear. In line seven, page 70, Fig. 4, Pl. IV, *should read* Fig. 2, Pl. IV. All the other organs of this Fig. are more advanced than in the other figures of this plate.

Fig. 3—Very much enlarged view of anterior end of embryo, viewed nearly ventrally. The ear is nearly enclosed; and the branchial slits, (page 69,) are formed.

Fig. 4—An earlier stage than Fig. 3. Three of the branchial slits are formed; the heart has become a two-chambered organ, (page 69); and a portion of the vitellus has concentrated into a large oil-sphere in the anterior part of the yolk mass, (page 69.)

Fig. 5—Posterior end of embryo. The portion under the notochord is splitting into two tracts, in which the great blood-vessels will soon be formed, (page 70.)

Fig. 6—Section of embryo in the anal region. The two tracts of Fig. 5 are seen, a and b, also the posterior end of the intestine, c, (page 70.)

PLATE V.

[The figures represented in this Plate were from hatched specimens, and were, excepting the adult forms, about three-sixteenths of an inch in length.]

Figs. 1 and 2—Profile and dorsal views of recently hatched Smelt. All the organs already described can be made out in still more advanced condition, (page 71.)

Fig. 3—Diagram of first blood-system of young Smelt, (page 73.) The first and third pairs of branchial vessels are not represented in the diagram, since they are often, if not always, formed at a later period.

Fig. 4—Very much enlarged view of young Smelt, at a period a little later than represented in Fig. 1, (page 72.)

Fig. 5—Head of Smelt at time of first blood-system, (page 72.)

Figs. 6 and 7—Views of fast disappearing yolk. The large oil-sphere is in the centre of the mass, is becoming very much smaller, and has turned of a brownish-yellow color.

Fig. 8—Profile view of adult female Smelt full of ova. Raritan river form, natural size.

Fig. 9—Head of same, with extended jaws.

Figs. 10 and 15—Stages in the development of the brain, (page 71.)

Fig. 11a—Scale, much enlarged, from above lateral line of Raritan river fish. b—same, natural size.

Fig. 12—Head of Northern Smelt

Figs. 13 and 16—Dorsal views of Raritan river and Northern Smelts.

Fig. 14—Brain of Raritan river fish, natural size.

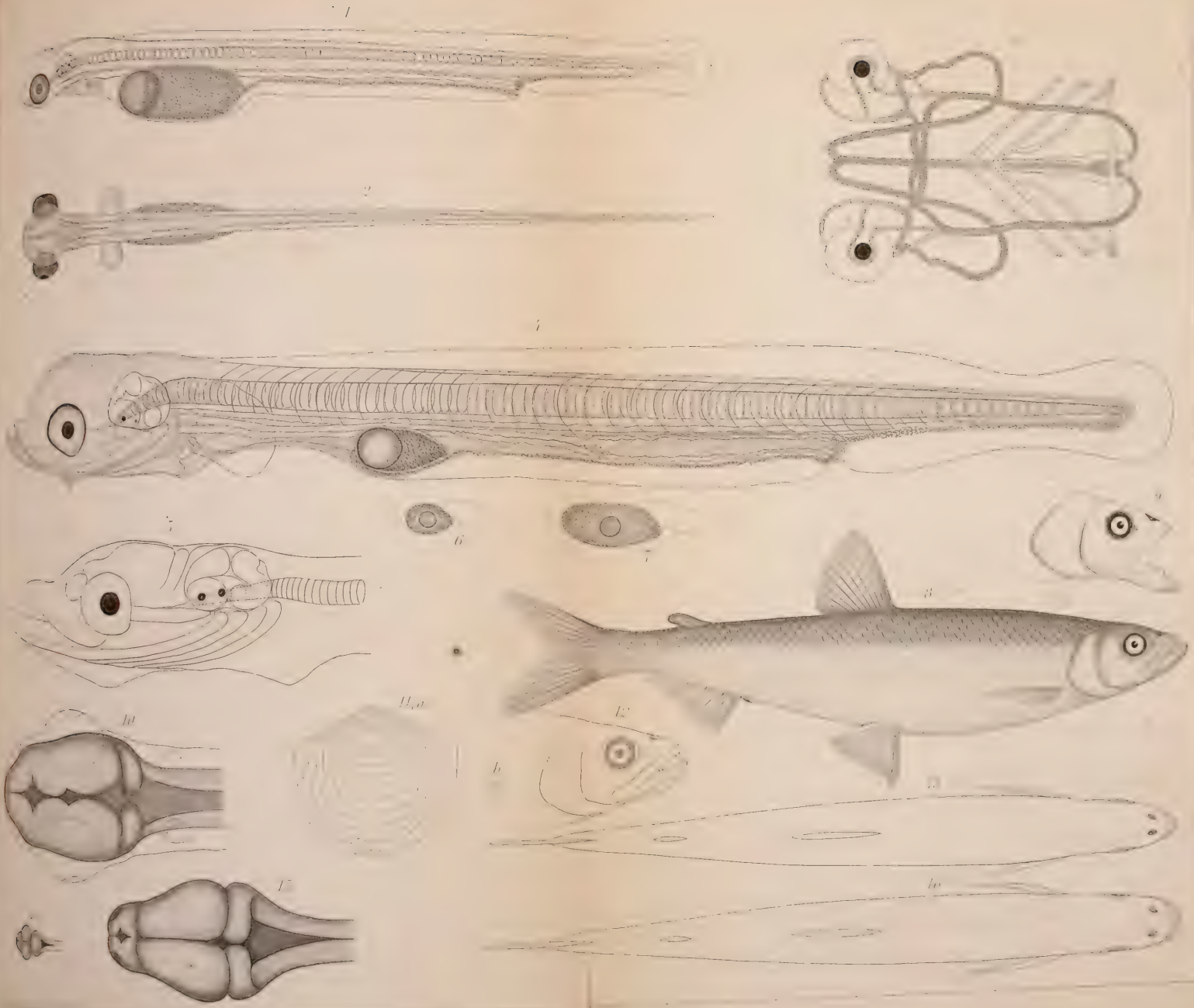


PLATE VI.

Fig. 1—Freshly spawned ovum of Shad, showing wrinkled and folded vitelline membrane, (page 97.)

Fig. 2—Ovum after having been in water for a few moments, (page 98.)

Fig. 3—Unimpregnated or impregnated swollen ovum, showing first stage of formation of "limb," (page 98.)

Fig. 4—Impregnated ovum, showing marking indicating first segmentation furrow, (page 100.)

Fig. 5—Unimpregnated, or impregnated, swollen ovum, showing "limb," (page 98.)

Fig. 6—Impregnated ovum, showing first segmentation furrow and marking indicating second, (page 100.)

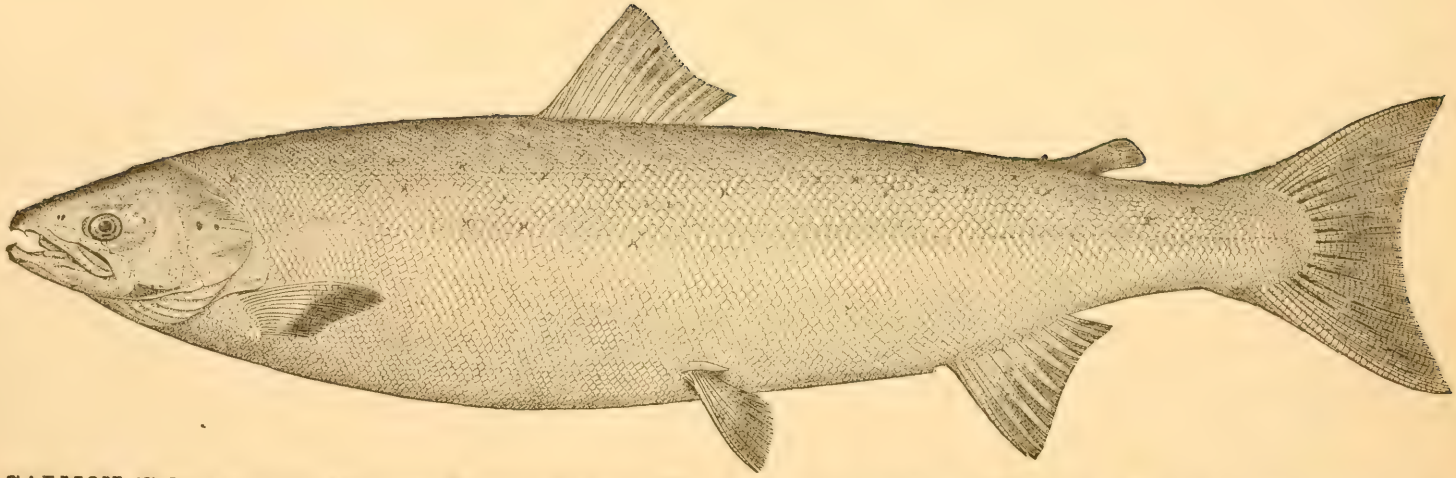
Fig. 7—Early stage of segmentation, (page 100.)

Fig. 8—"Mulberry" stage, (page 101.)

Fig. 9—Stage showing dorsal folds, (page 101.)

Fig. 10—One of the "irregulars," (page 104.)

Fig. 11—Ova natural size, (page 97.)



SALMON (Salmo salar), taken near Spesutie Island, Md., on the 11th of May, 1878. Length, 3′ 4″. Weight, 19 lbs.

REPORT

OF THE

COMMISSIONERS OF FISHERIES

OF

MARYLAND.

JANUARY, 1879.

ANNAPOLIS:
GEORGE COLTON, STATE PRINTER.
1879.

REPORT.

To his Excellency, JOHN LEE CARROLL,

Governor of Maryland:

The first Report of the Commissioners of Fisheries, being the record of the work done during the first two years of the existence of the commission, gave an account of the completion and successful working of the hatching house in Druid Hill Park; the introduction into our waters of the California salmon, the land-locked salmon, the Penobscot salmon, and the lake trout; the successful importation of European carp and tench; the establishment of carp ponds in Druid Hill Park, and also the hatching and distribution of 4,340,000 by the Maryland force and a deposit by the United States Commissioner in the Potomac River amounting to 4,885,550 young shad.

The second Report, published January, 1877, recorded the distribution of an additional number of fish of the above varieties; an important advance in the facilities for carrying on the work of the commission; the successful use of the steamer Lookout in collecting shad eggs from the several fisheries on the Potomac River and at the head of Chesapeake Bay, and the introduction of the adult spawning smelt into some of the rivers of the State, besides giving in detail the general work of the commission.

During this year 4,622,000 shad were hatched, of these 2,724,500 were placed in waters within the State of Maryland and 1,897,500 transferred to other localities.

The third report, that of January, 1878, chronicled an important advance in the methods of developing the eggs of shad and other fish independent of locality, by the use of two styles of apparatus. One consists of a series of conical vessels swung in gimbals on board the Lookout. These vessels were

supplied with a constant change of water by means of a steam pump, which kept a reservoir tank filled with water from overboard, distributing it to each of these vessels through the bottom or apex of the inverted cone, the overflow being wasted overboard. The other consisted of number of metallic cylinders with wire gauze bottoms, suspended in the water, to these cylinders an eccentric up and down motion was given by "cams" fixed on the constantly rotating shaft of a small steam-engine. The Report announced also an additional importation of the best varieties of European carp and tench, their successful transfer to the Druid Hill Park ponds, and successful experiments in propagating artificially the smelt—between four and five hundred thousand of these fish were hatched at New Brunswick, New Jersey, and transported to the waters of Maryland. As the smelt had never before been successfully propagated by fish culturists, this was an important step in the investigations of the Maryland Commission. The report also showed a gratuitous distribution of 50,480 brook trout to the citizens of Maryland.

During this year (1877) 8,444,300 shad were hatched, of these 7,319,300 were distributed in the State and 1,125,000 turned over to the United States Commissioner for other waters.

We are now able, in giving a summary of the work accomplished during the year 1878, to record another important advance in fish culture, the successful artificial propagation of the river herring As this fish, once exceedingly abundant and still very plentiful, is wonderfully fertile, there did not seem to be a necessity for its artificial propagation, but we have, during several seasons, looked carefully among the herring caught in the large haul seines in hopes of being able to secure a sufficient number of ripe adults to, at least, experiment with, but we did not succeed in finding any number of fish with the eggs in a proper stage of development. Their abundance, which is sufficiently great to indicate that they have not decreased to the same extent as the shad have, can be accounted for by the fact that their habits of spawning differ, and the localities selected by

them for this purpose are quite unlike the favorite spawning grounds of the shad. Whereas the shad prefer the open waters or extensive flats, the herring seek shoal places where can be found quantities of aquatic plants and sticks to which their eggs are attached. Such localities are generally out of the line of operations of fishermen, using either haul seines or gill nets, implements which readily capture the shad on their more exposed spawning grounds. Thus we can, at the same time, account for the continued comparative abundance of herring, while the decrease of shad has been so alarming, and also for the failure to find ripe herring among the masses which are landed at every haul of the large seines.

While conducting the joint shad hatching work of the Maryland and the United States Commissions on Albermarle Sound in North Carolina during last spring, we succeeded in securing near the head waters of a creek flowing into the sound, called Salmon Creek, a number of ripe herring, from which we obtained many hundreds of thousands of eggs. These were treated in a manner very similar to that pursued with the shad eggs, and they were placed in one of the shad hatching cylinders referred to. Although at first these eggs are very adhesive, and have to be handled with great care, they soon become somewhat free and can be hatched very readily. It has been demonstrated that as the necessity arises for the increase of herring by artificial means, they can be successfully propagated, although requiring the selection of other localities than those which have proved so favorable to shad culture. We deem it of some importance to have established the fact that the herring can be propagated artificially and in large numbers, as the necessity for this work will soon arise if indeed it does not already exist in some localities.

The large increase in the results obtained in our shad hatching operations was a consequence of the improvement and perfection of our apparatus. During the year 1878 9,820,000 of shad were hatched and distributed.

A filtering house to purify the water used in the hatching establishment in Druid Hill Park, and the addition also of

three large ponds for the propagation of carp, were completed during this year.

The continuation of the work in hatching and distributing the several varieties of the salmon family has been conducted on the usual scale. The capture of an adult salmon, *salmo salar*, at the mouth of the Susquehanna river, evidently fresh run from the ocean on its way to seek spawning grounds in the upper waters of this river, or some of its tributaries, is an indication of the success of the efforts to introduce this most valuable fish into the waters of Maryland.

Brook Trout—*Salmo fontinalis.*

During the year 1876 we procured a limited supply of eggs of the brook trout, *salmo fontinalis*, and when they were in the hatching house we issued the following circular, which was printed in many papers throughout Maryland.

"*Messrs. Editors:*

"We have been induced by the many applications for Brook Trout (*Salmo fontinalis*) received during the past three years, to secure a number of eggs of this fish, which are now in the hatching apparatus at Druid Hill Park.

"When hatched and ready for distribution, the young will be devoted to the re-stocking of depleted waters of the State. We will be prepared to distribute them during the month of February, and request that applications by those wishing to stock waters with this fish be made to us by the first of February. Those applying are requested to describe accurately the waters to be stocked, extent, locality, source of supply, into what stream or bay they are discharged, character of bottom and water-grasses, kind of fish now inhabiting, etc.

"The means at the disposal of the Commission renders it impossible to transport the fish at the expense of the appropriation; so in all cases they must be transported at the expense of the persons applying for them.

"No charge will be made for the fish, but the Commission will decide the adaptability of the waters and localities, and will notify those persons whose applications are approved, of the time and number of fish which will be delivered to them at the hatching house.

"In making the apportionments, preference will be given to those wishing to stock public streams, and to clubs organized for the protection of game and fishes in the State.

"It is hoped that in course of time, with increased facilities for procuring eggs, we will be able to give to *all* persons wishing them, who will properly distribute the fish, as many as they wish.

"We would be glad if those taking an interest in the restocking of our waters would send specimens, either fresh or in alcohol, of fishes, large and small, and any other animal life inhabiting their waters, noting the locality from which taken, to No. 192 North Charles street, Baltimore.

"By giving publicity to this proposed work of the Commission, you will greatly oblige us, and perhaps benefit your numerous readers. Yours truly,

"T. B. Ferguson, *Commissioner.*"

The distribution was made in the spring of 1877. The trout were delivered to thirty-four applicants and planted in the waters of several counties, as recorded in the table of distribution published in the report of January, 1878.

There were of course a great many applications for trout which could not be met out of the limited supply of something over 50,000. This caused us, during the year 1877, to procure a very much larger supply of eggs, as reported on page 17 of the report of January, 1878. With the number on hand it was not deemed necessary to issue orders for the trout, but notice was given in several of the papers, and a circular to the same effect was very generally distributed, informing the public that any citizen of Maryland could obtain as many trout as he wished by applying at the Druid Hill Park for them.

The employee in charge of the hatching house was instructed to deliver to any citizen of Maryland as many trout as the applicant had means of transporting. There was no limitation made, and the citizen soliciting the trout was simply required to sign a receipt for those he received in the following form:

Maryland Commission, Fish and Fisheries,
Druid Hill Hatching House.

This is to Certify that I am a citizen of Maryland, and reside at.....county; that I have this day received of T. B. Ferguson, Commissioner of

Fisheries.....Brook Trout, to stock
.....a tributary of.....
and that I will deposit them in the above mentioned waters,
.....1878. .....

This distribution, which commenced on January 15th and closed May 26th, amounted to 234,500, and 104 persons were recipients of Brook Trout. Every applicant was supplied with as many as he could well carry away in the vessels brought with him to the Hatching House for the purpose, until the supply was exhausted, on the 26th of May. The details of this important distribution will be found in the following table:

RECORD OF DISTRIBUTION OF BROOK TROUT *made from January 15 to May 29, 1878, by Maryland Commission of Fisheries, under the direction of the Commissioners.*

Date. 1878.	No. of Fish.	To Whom Issued.	Pond or Stream.	Tributary of	Place.
January 15	500	S. W. Wilderson	.....	Patapsco River	.....
" 15	500	F. Frayber	.....	.....	Poplar Hill Park, Baltimore county.
" 15	500	S. V. Trump	.....	Gunpowder River	.....
" 15	1000	J. Welty	.....	Antietam River	.....
" 15	1000	George Ortel	.....	Back River	.....
" 16	500	F. M. Sparks	Stream	Big Gunpowder	Monkton, Baltimore county.
" 17	1500	Charles White	Cabin Branch	Beaver Dam and eastern branch Potomac	Wilson's Station, Prince George's co.
" 17	1000	Frank Englar	Pond	Lingamore Creek, a branch of Monocacy	Linganore, Frederick county.
" 17	1000	Jos. A. Hayghe	Pond	Little Gunpowder	Upper Cross Roads, Harford county.
" 17	1000	Thomas Dixon	The Western Branch	The West Branch	Mount Washington, Baltimore county.
" 18	1000	A. H. Hull	Long Branch	Bush Run	Forest Hill, Harford county.
" 18	1000	James H. Ridgeway	Pond and Stream	Wye River	Skiplin, Talbot county.
" 18	1500	E. F. Abell	Pond	.....	Govanstown, Baltimore county.
" 18	2000	Edward Wilkens	.....	Chester River	Riversides, Kent county.
" 19	500	John Tubbs	Saw Mill Branch	Curtis' Creek	Anne Arundel county.
" 19	500	George M. Ehrman	Stony Run	Patapsco River	Baltimore, Baltimore county.
" 22	1500	E. A. Cockey	Stream	Jones' Falls	Pikesville, " "
" 22	1500	H. L. Naylor, M. D.	"	" "	" " "
" 22	500	Thos. H. Whatand	Pond	Chester River	Chestertown, Kent county.
" 22	500	Mrs S. M. Hamilton	"	Gwynn's Falls	8 South Gay street, Baltimore.
" 22	1000	J. J. Turitt	"	Nanticoke River	Galestown, Dorchester county.
" 22	1000	H. B. Fletcher	Cabin Creek	Big Choptank	East New Market, Dorchester county.
" 22	1000	J. H. Greenway	Stream	Swan Creek	Near Havre-de-Grace, Harford county.
" 22	3000	R. H. Woolen	Deep and Shoemaker	Jones' Falls	Brooklandville, Baltimore county.
" 23	3000	S. T. Magruder	Green's Branch	Octorara Creek	Colora, Cecil county.
" 23	3000	Thomas J. Myer	Brook	Gwynn's Falls	Pikesville, Baltimore county.

RECORD OF DISTRIBUTION OF BROOK TROUT *made from January 15 to May 27, 1878, by Maryland Commission of Fisheries, under the direction of the Commissioners*—Continued.

Date. 1878.	No. of Fish.	To Whom Issued.	Pond or Stream.	Tributary of	Place.
January 23	3000	E. Hermann	Stream and Pond	Swan Lake	Sheppard Asylum, Somerset county.
" 24	3000	Nathaniel Watts	Avondale Branch	Gwynn's Falls	Pikesville, Baltimore county.
" 24	2000	J. D. Thompson, M.D.	Gunpowder Mills Br.	" "	Arlington, Baltimore county.
" 25	3000	T. W. Ware	Bradford Run	Patapsco "	North Branch, " "
" 25	4000	Samuel Ammen	Piney Branch	The Eastern Branch	Annandale Way St'n, Prince George co.
" 26	2000	Samuel Tagart	Stream	Gwynn's Falls	McDonogh Ins., Owing's Mills, Balto. co.
" 28	2000	Dr. F. D. Mitchell	Stream and Pond	The Gunpowder	Near Glencoe, Baltimore county.
" 28	6000	James Stansbury	Deer Creek	Susquehanna	Clermont Mills, Harford county.
" 29	1000	A. G. Watts	Stream	Patapsco River	274 Lexington street, Baltimore.
" 29	1500	David Hoopes	"	Deer Creek	Hickory P. O., Harford county.
" 30	2000	Henry Mittnacht	Gwynn's Falls	Patapsco River	Baltimore, Baltimore county.
" 31	4000	J. S. Wetter	Pond	North-East "	Seneca Pt. Club, Charlestown, Cecil co.
February 2	9000	T. H. Shriver	Big Pipe Creek	Monocacy "	Union Mills, Carroll county.
" 4	3500	J. T. Towson	Pond and Spring	Beaver Creek	Smithsburg, Washington county.
" 4	500	S. W. Wilderson	Pond	" Run	Carrollton, Carroll county.
" 5	1000	Dr. H. H. Hopkins	Creek	Patapsco River	New Market, Frederick county.
" 5	500	Philip H. Stouffer	Pond	Little Pipe Creek	New Windsor, Carroll county.
" 5	5000	S. M. Shoemaker	Bar Branch	Green Spring Branch	Sevenson Station, Baltimore county.
" 6	3000	J. L. Hammerslo	Pond	Antietam River	Hagerstown, Washington county.
" 7	5000	Lewis Vogle	Vault Branch	Long Quarter Branch	Towsontown, Baltimore county.
" 7	3000	F. Frayber	Pond	Gwynn's Falls	Poplar Hill Park, Baltimore county.
" 7	3000	Alex. Riddell	Annandale Stream	" "	Pikesville, Baltimore county.
" 8	4000	A. C. P. Shoemaker	Stream	Rock Creek	Rock Creek, Montgomery county.
" 8	4000	J. A. Shriver	"	Winter's Run	Wilnid, Harford county.
" 9	500	Jos. Menshaw	Saw Mill Branch	Curtis' Creek	Brooklyn, Anne Arundel county.
" 10	6000	W. A. Cunningham	Pond and Stream	Little Pipe Creek	Westminster, Carroll county.
" 11	4000	George Brown	Stream	Green Spring Branch	Brooklandville P. O., Baltimore county.
" 12	4000	William Baldwin	Gunpowder	Gunpowder River	Upper Cross Roads, Harford county.

RECORD OF DISTRIBUTION OF BROOK TROUT *made from January 15 to May 27, 1878, by Maryland Commission of Fisheries, under the direction of the Commissioners*—Continued.

Date. 1878.	No. of Fish.	To Whom Issued.	Pond or Stream	Tributary of	Place.
February 12	5000	W. H. Brown	Stream	Choptank River	Jamaica Point, Talbot county.
" 12	5000	Elisha Riggs	"		Gaithersburg, Montgomery county.
" 13	4000	D. C. Fulton	The Tiber	Patapsco River	Ellicott City, Howard county.
" 13	4000	Milton Whitney, Jr.	Stream	Severn "	Waterbury, Anne Arundel county.
" 13	6000	Michael Walsh	East Branch	Patapsco "	Patapsco Station, Carroll county.
" 13	6000	Henry Stibbs	North "	" "	" " " "
" 14	1000	David S. Wilson	Indian Spring Run	" "	——, Baltimore county.
" 15	100	W. B. Roby	Stream		Laurel, Prince George's county.
" 15	1000	Thos. R. Coward	"		" " " "
" 16	500	R. W. Griffith	Wild Cat Branch	Curtis' Creek	Brooklyn, Anne Arundel county.
" 16	1000	John Tubbs	Pond	" "	" " " "
" 19	3000	John S. Gittings	Long Green Branch	Gunpowder	Baldwin P. O., Baltimore county.
" 19	3000	Samuel Appleby	Stream	Patuxent River	Oakland Mills, Howard county.
" 19	4000	Miss May Williams	Broad and ——		Ranger's Lodge, Harford county.
" 19	4500	John P. Knox	Stream	Patapsco River	Bird Hill, Carroll county.
" 20	5000	C. H. Mann, Jr.	Owen's Run	Herring Run	Towsontown, Baltimore county.
" 20	5000	C. H. Mann, Jr.	Stansbury Run	" "	" " "
" 20	4000	Frank Cockey, M. D.	Stream	Roland "	Lutherville, " "
" 20	4000	Charles B. Rogers	"	Jones' Falls	Brooklandville, " "
" 20	3000	Charles Kemp	Indian Run	Western Run	Black Rock P. O., " "
" 20	1000	P. H. Walker	Stream and Pond	Jones' Falls	Pikesville, " "
" 21	5000	John W. Armasort	Piney Run	Western Run	Trenton, " "
" 21	2000	Samuel J. Garber	Pond	Little Pipe Creek	New Windsor, Carroll county.
" 21	2000	Charles A. Manning	Beaver Dam Creek	Monocacy	Near Emmittsburg, Frederick county.
" 22	2000	E. B. Nicewaner	Israel Creek	Potomac	Baltimore, Baltimore county.
" 22	2000	Daniel Rinehart	Marble Spring Bran.	Sam's Creek	Near Union Bridge Frederick county.
" 23	6000	Edward Wilkens	Stream and Pond	Chester River	Riverside, Kent county.
" 23	3000	J. G. Mathews	Stream	Swan	Havre de Grace, Harford county.

RECORD OF DISTRIBUTION OF BROOK TROUT *made from January 15 to May 27, 1878, by Maryland Commission of Fisheries, under the direction of the Commissioners*—Continued.

Date. 1878.	No. of Fish.	To Whom Issued.	Pond or Stream.	Tributary of	Place.
February 23	500	John F. Gore	Gwynn's Falls	Patapsco	Reisterstown, Baltimore county.
" 25	6000	George N. Moale	Stream		Near Owings' Mills, Baltimore county.
" 25	3000	James L Read	Branch	Herring Run	Lauraville, Baltimore county.
" 27	300	Henry E. Beltz	"	Great Gunpowder	Manchester, Carroll county.
" 28	1000	Horace S. Owings	Stream—500 Ludlow, 500 Crystal Trout.	Potomac	Clarksville, Howard county.
March 2	500	J. Grumm	Little Antietam	"	Rahren's Hill, Washington county.
" 2	300	J. Grumm	" "	"	" " " "
" 4	600	J. A. Miller	Pond	"	Weavertown, " "
" 7	300	Amos Spencer	Stream	Patuxent	Spencerville, Montgomery county.
" 19	400	Thomas C. Yearly	Spring Branch		The Pines, Baltimore county.
" 23	3000	John S. Donaldson	Rockburn "	Patapsco River	Elk Ridge, Howard county.
" 25	300	James Lee	Stream		Owings' Mills, Baltimore county.
" 25	300	Thomas C. Wood	"	Gwynn's Falls	" " " "
" 26	1000	William Webster	Pond	The Gunpowder	Cockeysville, " "
" 27	1000	M. S. Brilherst	"	N Branch of Potomac	Hampstead, Carroll county.
" 28	200	C. T. Haile	"	The Long Green	Long Green, Baltimore county.
" 28	300	John E Howard	Branch	Gwynn's Falls	Pikesville, " "
" 28	600	R. M. Howard	"	Gunpowder	Monkton, " "
" 29	100	T. R Appold	Stream		Baltimore, " "
April 4	500	W. H. Perkins	"	Potomac	Hancock, Washington county.
" 26	500	John T. Donaldson	Rockburn Branch	Patapsco	Elkridge, Howard county.
May 27	100	R. D. Cox	Harlem Park		Baltimore, Baltimore county.
About Feb. 9	200	R. D. Cox	Jackson Sq. Fountain		" " "
	234,500				

On the 30th of November we secured 100,000 Brook Trout eggs. These are now in the Hatching House, and the disposition made of them will be given in our report of the work accomplished next year. Through this system, many streams of the more northern counties, which have been exhausted of trout, have been restocked, and many streams in which the trout has hitherto been unknown, have been sufficiently stocked to test their capacity to support this fish—the great favorite of the angler. It is hoped that the fish, which have been so generally distributed through the State, will add to the comfort and the food resources of the districts which have been reached, and we trust that the interest which has been created by the visits to the Hatching House by those soliciting trout, and a more accurate conception of the natural history of the fishes, which resulted from these visits, has excited a strong desire for the protection of the fish deposited, and a determination to make a more rational use of the bounteous yield of our waters.

Salmon (*Salmo salar*).

Soon after the establishment of the Maryland Commission of Fisheries, Prof. Baird presented the State with 80,000 salmon eggs. These eggs were issued by the United States from the hatching establishment at Bucksport, Maine. They were turned over to Mr. Alex. Kent, who had at that time, a trout hatching establishment in Green Spring Valley, about twelve miles from Baltimore. There was a considerable loss of eggs and of the young fish after they were hatched, but of those surviving a greater portion were placed in the upper waters of the Potomac River, some in the headwaters of Deer Creek, which flows into the Susquehanna River, above Havre-de-Grace, and the rest in Octorara Creek, a stream in Cecil county, also flowing into the Susquehanna, above Port Deposit.

We were not hopeful of any results from the introduction of the salmon of Maine, as it has been known only in the coldest waters. We therefore devoted our attention

rather to the salmon of the Pacific-slope, which, on the contrary, were known to ascend rivers in which the water at times reached a very high temperature. Contrary to our expectations, the true salmon have returned to the Delaware River in some abundance, a great many adults having been taken during the last two years in this river. On the night of the 11th of May, Mr. Frank Farr, one of the gillers of Havre-de-Grace, who had been in the habit of furnishing us with the ripe shad taken in his gill-net, secured the first adult salmon of which we have any record, taken in Maryland waters. This fish was a female, measuring three feet four and a half inches, and weighing about seventeen lbs., fresh run from the sea.

The fish was captured off Spesutie Island, having been entangled in the gill-net, which was much torn, and Mr. Farr, who captured it, is confident that at least one other fish accompanied the one taken, but made its escape.

The gillers are in the habit of having their nets much torn by sturgeon, and no doubt have attributed to them many casualties which may have been occasioned by salmon.

The fish was secured by Prof. J. W. Milner, directly after it was taken, and sent to the Smithsonian Institution. A plaster cast has been made, and the fish is now in the National Museum preserved in alcohol.

Should the true salmon appear in any numbers, it will be well for the work of depositing the young in the waters of Maryland to be continued on a large scale. This fish is not only very attractive to anglers, but is one of the most valuable of the food fishes, both of the North Atlantic Coast of America and of British waters.

Land Locked Salmon.

On the 12th of January 50,000 eggs of this valuable fish, a present from the United States Commissioner, were received at the Hatching House. On unpacking them only 740 dead eggs were found. The eggs were all hatched prior to the

1st of March. The distribution commenced on the 4th of that month, and ended on the 10th of May. On the 26th of April 23,000 were deposited in the upper waters of the Gunpowder River, and on the 10th of May 7,831 were sent to Deer Park. This distribution, which aggregated 40,781 in the waters of Maryland, will be found in detail in table here given:

[See table on next page]

RECORD OF DISTRIBUTION OF LAND-LOCKED SALMON *made from March 4 to May 10, 1878, by Maryland Commission of Fisheries, under direction of the Commissioners.*

Date. 1878.	No. of Fish.	To Whom Issued.	Pond or Stream.	Tributary of	Place.
Mar. 4	700	J. A. Miller.....	Pond.....	Potomac River.....	Weaverton, Washington county, Maryland.
7	500	Amos Spencer.....	Stream.....	Patuxent "	Spencerville, Montgomery " "
19	2500	D. G. Adelsberger...	Crystal Iron Springs.	Monocacy "	Emmittsburg P O, Frederick county, "
April 5	1000	J. P. Armstrong.....	Pond.....	Patuxent "	Forestville, Prince Georges " "
16	3000	A. B. Davis.....	"	Patapsco "	Hood's Mills, "
17	250	J. F. Gore.....	"	Gwynn's Falls.....	Reisterstown, Baltimore county, "
26	500	John T. Donaldson..	Cascade Branch.....	Patapsco River.....	Elkridge, Howard " "
26	23,000	William Hemlen.....	Gunpowder River...	.....	Cockeysville, "
30	500	A. B. Davis	Pond.....	Patapsco River.....	Hood's Mills, "
May 2	1000	H. L. Motter.....	"	" "	Westminster, Carroll county, "
10	7831	....	"	.....	Deer Park, "
	40,781				

In addition to this work for Maryland, we offered the facilities of the Hatching House to Prof. Spencer F. Baird, United States Commissioner, through whose liberality we had received this large supply of eggs, for the purpose of hatching the eggs and caring for the young fish, which he desired to distribute to the States of North Carolina and Georgia, the State of North Carolina paying the expenses incurred in hatching for that State and the United States Commission paying the actual cost of caring for the eggs intended for the State of Georgia.

With ample facilities in the Hatching House at Druid Hill Park, we have endeavored to reciprocate as far as in our power the many favors that we have received at the hands of the United States Commissioner, and to render some assistance to our sister States who have only just established or are without Commissions for carrying on the work of repeopling their waters.

California Salmon—(*Salmo quinnat*).

During the year 1877 119,500 salmon of this variety were placed in the streams of the State. Late in the fall 180,000 eggs, in addition to the eggs from which these fish were produced, were received through the kindness of the United States Commissioner, and the young fish, when hatched, 169,100 in all, were distributed during March and April of 1878, as will appear in the following table:

RECORD OF DISTRIBUTION OF CALIFORNIA SALMON *made from March 4, 1878, to December 31, 1878, by Maryland Fish Commission, under direction of the Commissioners.*

Date of Transfer.	Obtained from	Place Whence Taken.	No. of Fish.		Introduction of Fish.			Transfer in Charge of	
			Originally taken.	Actually planted.	Place.	Stream.	Tributary of		
1878.									
March 4	Prof. Spencer F. Baird, U. S. Fish Commission.	Druid Hill Hatching House.	600	600	Weaverton	Pond	Potomac River.	J. A. Miller.	
" 7			500	500	Spencerville	Patuxent River.	Chesapeake Bay.	Amos Spencer.	
" 11			10,000	10,000	Laurel	Patuxent River.	Chesapeake Bay.	Wm. Hamlen.	
" 12			10,000	10,000	Parkton	Gunpowder Riv.	Chesapeake Bay.	"	"
" 14			20,000	20,000		...Tributaries of	Potomac River..	* "	"
" 16			10,000	10,000	Hood's Mills	Patapsco River..	Chesapeake Bay.	"	"
" 18			12,000	12,000	Savage	Patuxent River.	Chesapeake Bay.	"	"
" 21			12,000	12,000	Weaverton	Potomac River..	Chesapeake Bay.	"	"
" 22			12,000	12,000	Sir John's Run	Potomac River..	Chesapeake Bay.	"	"
" 22			1,000	1,000		Pond	Bear Creek	Isaac H. Wright.	
" 25			8,000	8,000	Laurel	Patuxent River..	Chesapeake Bay.	Wm. Hamlen.	
" 26			20,000	20,000	Keyser, W. Va.	..Potomac River	and tributaries..	"	"
April 1			5,000	5,000	Tank Station	Patapsco River .	Chesapeake Bay.	"	"
" 1			7,000	7,000	Double Pipe Creek.	Patapsco River..	Chesapeake Bay.	"	"
" 1			6,000	6,000	Hood's Creek	Patapsco River..	Chesapeake Bay.	"	"
" 3			35,000	35,000	Weaverton	Potomac River..	Chesapeake Bay.	"	"
Total from eggs received in 1877...			169,100	169,100					

* Fish delivered to Mr. C. S. White, Commissioner for W. Va.

The above were from eggs received in 1877.

During the month of October, 1878, the Hatching House gave proof of its capacity to accommodate a very large number of eggs at one time, for on the 5th of that month 525,000 of the eggs of the California Salmon were received from the United States Hatching Station, on the McCloud River, and a few days subsequent, the 14th, another lot of 525,000 were received from the same source and placed in the hatching apparatus.

The first lot of eggs commenced hatching on October 16th, but, as this was somewhat premature, caused, most probably, by the long transportation across the continent, and possibly some overheating, the fish were not very healthy. On the 21st of the same month all the eggs of the first lot were hatched.

On the 26th of the same month, while some repairs were being made to the distributing pipes of the Water Works of the city of Baltimore, the water was stopped for some time in the Hatching House, and this caused a loss of 60,000 fish.

The second lot (those received on the 14th of October) were all hatched by the 2d of November. The distribution from the first lot commenced on the 6th of that month, and 209,000 were placed in the waters of Maryland, between the 6th and 13th of the month.

On the 27th the distribution from the second lot was commenced, and up to the 27th of December 332,500 were successfully deposited in the streams of the State.

RECORD OF DISTRIBUTION OF CALIFORNIA SALMON *made from March* 4, 1878, *to December* 31, 1878, *by Maryland Fish Commission, under direction of the Commissioners.*

Date of Transfer.	Obtained from	Place where taken.	No. of Fish.		Introduction of Fish.			Transfer in Charge of
			Originally taken.	Actually planted.	Place.	Stream.	Tributary of	
Nov. 6	Prof Spencer F. Baird, U. S. Fish Commission.	Druid Hill Hatching House.	28,000	28,000	Cockeysville, Md..	Gunpowder Riv.	Chesapeake Bay.	W. H. Hines & W. H. Busch.
" 7			24,000	24,000	Laurel.....	Patuxent River .	Chesapeake Bay.	W. Hamlen & W. H. Busch.
" 7			18,000	18,000	Savage.....	Little Patuxent R	Patuxent River .	W. H. Hines & W. H. Busch.
" 8			7,500	7,500	Scintman's Mill....	Big Elk River...	Chesapeake Bay.	Thomas Hughlett.
" 8			7,500	7,500	Rock Church.....	Little Elk River.	Chesapeake Bay.	Wm. Hamlen
" 9			15,000	15,000	Near North East...	North East Creek	North East River	Thos Hughlett & W. H. Hines.
" 9			10,000	10,000	Tank Station	Patapsco River..	Chesapeake Bay.	Wm. H. Busch.
" 9			13,000	13,000	Near New Windsor	Pipe Creek	Monocacy River.	Wm. H. Hines.
" 9			13,000	13,000	Nr. Mechanicstown	Owen's Creek...	Patapsco River..	J. H. Hines
" 11			25,000	25,000	Laurel.....	Patuxent River..	Chesapeake Bay.	J. H. Hines.
" 11			12,500	12,500	Savage..	Little Patuxent R	Patuxent River..	Wm. H. Busch
" 12			15,000	15,000	Millington.....	Chester River...	Chesapeake Bay.	Thos. Hughlett & W. H. Hines.
" 13			6,000	5,500	Hillsborough	Tuckahoe Creek.	Choptank River.	Thos. Hughlett & W. H. Hines.
" 13			15,000	15,000	Sykesville.....	Patapsco River .	Chesapeake Bay.	Wm. Hamlen.
" 27			20,000	20,000	Monkton.....	Gunpowder Riv.	Gunpowder Riv.	Wm. Hamlen.
" 28			20,000	20,000	Near Monkton.....	Gunpowder Riv.	Gunpowder Riv.	W. Hamlen & W. H. Jenkins.
" 29			20,000	20,000	Fort Pendleton....	N. br. Potomac..	Potomac River..	Thos. Hughlett & W. Hamlen.
" 30			20,000	20,000	Fort Pendleton....	N. br. Potomac..	Potomac River..	Thos. Hughlett & J. H. Hines.
Dec. 1			25,000	24,500	Nr. Fort Pendleton	N. br. Potomac..	Potomac River..	Wm. Hamlen.
" 2			20,000	20,000	Near Swanton.....	N. br. Potomac..	Potomac River..	Thos. Hughlett & J. H. Hines.
" 4			15,000	15,000	W. Virginia.....	...Tributaries of	Potomac River..	Wm. Hamlen.

RECORD OF DISTRIBUTION OF CALIFORNIA SALMON *made from March* 4, 1878, *to December* 31, 1878, *by Maryland Fish Commission, under direction of the Commissioners*—Continued.

Date of Transfer.	Obtained from	Place whence taken.	No. of Fish.		Introduction of Fish.			Transfer in Charge of
			Originally taken.	Actually planted.	Place.	Stream.	Tributary of	
Dec. 4	Prof. Spencer F. Baird, U. S. Fish Commission.	Druid Hill Hatching House.	20,000	20,000	Near Henderson...	Choptank River.	Chesapeake Bay.	Thos. Hughlett & J. H. Hines.
" 6			20,000	6,000 8,000 6,000	Near Boyd's.....	Ten Mile Cr. Lit. Lonem.. Buck Lodge.	Potomac River..	Wm. Hamlen.
" 7			20,000	20,000	.....	Monocacy River.	Chesapeake Bay.	Wm. Hamlen.
" 9			20,000	10,000	Hillsborough	Nanticoke River.	Chesapeake Bay.	Wm Hamlen.
" 12			20,000	12,000 8,000	Mitchell's br'ge Abv. Snow Hill	Pocomoke River.	.....	W. Hamlen & Thos. Hughlett.
" 12			20,000	20,000	Near Towsontown	Gunpowder Riv.	.....	W. H. Jenkins.
" 13			20,000	20,000	Mt. Airy.....	Patuxent River..	.....	F. W. Wilson & W. H. Jenkins.
" 14			10,000	10,000	Hillen Rd. Crossing	Herring Run....	.....	W. H. Jenkins.
" 16			10,000	10,000	Near Seaford.....	Nanticoke River.	.....	W. H. Jenkins & T. Hughlett.
" 17			12,000	12,000	Millington	Chester River ..	.....	W. H. Jenkins & T. Hughlett.
" 17			1,000	1,000	Middleton.....	Stream	Gunpowder Riv.	Bennett T. Hoshall.
" 19			10,000	10,000	Nr. Liberty Grove.	Octorara Creek..	Susquehanna Riv	T. Hughlett & W. H. Jenkins.
" 21			20,000	20,000	Near Parkton.....	Deer Creek	Susquehanna Riv	W. H. Jenkins, Jr.
Total from eggs received Oct., 1878.			552,500	541,500				
Aggregate distribution during year			721,600	710,600				

The above were from eggs received in Fall 1878.

Thirty-five thousand of the second lot were turned over to the United States Commissioner for distribution to the waters of the Southern States; the balance of the fish will be distributed during the spring of 1879, and the details will appear in the report of January, 1880.

A review of the tables of distribution of California Salmon in Maryland waters during the five years of the existence of the Commission shows an aggregate of 2,224,904.

That is, in—

1874	144,000
1875	91,500
1876	1,028,304
1877	250,500
1878	710,600
	2,224,904

The points at which the salmon were deposited and the rivers stocked will be found in the several tables of distribution given in reports already published.

RECORD OF DISTRIBUTION OF CALIFORNIA SALMON *made from December* 18, 1878, *to December* 27, 1878, *by United States Fish Commission, under direction of T. B. Ferguson, Commissioner for Maryland.*

Date of Transfer.	Obtained from	Place whence taken.	No. of Fish.		Introduction of Fish.			Transfer in Charge of
			Originally taken.	Actually planted.	Place.	Stream.	Tributary of	
Dec. 18	U. S. Salmon breeding station, McCloud Riv., Cal.	Druid Hill Hatching House, Baltimore, Md.	3,750	3,750	Milledgeville, Ga..	Oconee River.....	Altamaha River...	William Hamlen.
" 18			3,750	3,750	Macon, " ..	Ocmulgee "	" " ..	William Hamlen.
" 18			3,750	3,750	Covington, " ..	Yellow "	Ocmulgee " ...	William H. Busch.
" 18			3,750	3,750	" " ..	Ocmulgee "	Altamaha " ..	William H. Busch.
" 27			4,000	4,000	Seneca City, S. C..	Seneca "	Savannah " ...	*William Hamlen.
" 27			3,000	3,000	Shallow Ford, Ga .	Chattahoochee Riv.	Appalachicola Riv.	†William Hamlen.
" 27			3,000	3,000	Balding's Mills, " ..	Chastatee "	" "	William Hamlen.
" 27			4,000	4,000	Jonesboro', " ..	Flint "	" "	William H. Busch.
" 27			2,000	2,000	Carteville, " .	Etowah "	Coosa "	William Hamlen.
" 27			2,000	2,000	Resaca, " ..	Coosa "	Alabama "	William Hamlen.
" 27			2,000	2,000	Oxford, Ala.....	Cold Water Creek.	Coosa "	William Hamlen.
			35,000	35,000				

* Mr. Thomas. G. Clemson met these fish at Seneca City, and placed them in the river.

† Mr. J. H. Butts met these fish at Gainesville, Ga., and placed them in the rivers.

SHAD—(*Alosa sapidissima.*)

In accordance with the programme suggested on page 27 et seq. of the last report of the Commissioner, he, together with Col. Marshall McDonald, Commissioner of Fisheries for Virginia, and Col. L. L. Polk, having charge of the Department of Fish Culture in North Carolina, had a consultation with Prof. Baird at the Smithsonian Institution. Prof. Baird then informed us of his readiness to undertake the work of shad hatching on the Albemarle Sound, and signified his willingness to turn over to the Commissioners of each of these States a large portion of the yield of young shad for distribution in those several States. We agreed to contribute on behalf of Maryland the services of the "Lookout" and all of the shad-hatching appliances, and it was, at the same time, arranged with Prof. Baird that the whole equipment should be moved from Albemarle Sound at the close of the season (for that latitude about the first of May) to the head of the Chesapeake Bay, and the work of shad hatching continued at that point, the season opening at the head of Chesapeake Bay about the same time that it closes on the Albemarle Sound.

With a view of carrying on the work on the Albemarle Sound and at the "Head of the Bay" on a large scale, we had secured for Prof. Baird, by purchase from the city of Baltimore, the four scows, which had been rented from the Harbor Board, and during the winter they were thoroughly repaired and fitted for the work, under the superintendence of Capt. H. C. Chester, who was ordered to report to us by the United States Fish Commissioner.

The repairs and equipment of these scows was done by the men who had been trained for the work of shad hatching by the Maryland Commission, and in that way we were enabled to get together and keep the corps of trained experts, so that they were in readiness to move at the opening of the season.

The outfit being in readiness, on the 21st of March it left Baltimore in tow of the steamer "Ewing," of the Revenue Service, Capt. Fengar, commanding, who had been ordered by the Secretary of the Treasury to take them as far as Nor-

folk, Va.: from that place they were towed through the Albemarle and Chesapeake Canal by tow-boat, and reached Salmon Creek, near the mouth of Chowan River, on the 25th of the month.

On the 28th of March two ripe female shad were found, and the eggs taken, but it was not until the 1st of April that the spawning shad appeared in any considerable numbers; on the night of that day we secured 225,000 eggs.

The steamer Lookout having been thoroughly overhauled, and the hatching apparatus remodelled, reached Salmon Creek on the 3d of April with a steam launch in tow, which had been secured from the Navy Department.

The equipment at Salmon Creek, at this time, consisted of one barge, with the machinery to be used for hatching, and two others which were fitted up as quarters for the corps, the steamer Lookout having hatching apparatus with a capacity of 1,500,000 eggs and a steam launch, which was to be used in the collection of eggs from the neighboring fisheries, besides some half dozen rowboats, which were also to be used in securing from the adjacent fisheries the ripe fish taken at each haul of the seines. In addition to these, there was erected at Scotch Hall Fishery, owned by Dr. Wm. R. Capehart, a hatching equipment of six cones. These were supplied with water by a steam pump which was run by steam from the boiler of one of the engines used to haul in the large seine of the fishery.

Having secured a large number of eggs by the 9th of April, the steamer Lookout left the station with about a million and a half of eggs, which were to be hatched en route up the Chowan River to Franklin, Va., a station on the Seaboard and Roanoke Railroad where it crosses the Blackwater River. All of these eggs were hatched by the 12th, and the fish distributed. The steamer then returned to Avoca to continue the work at that point.

On the 15th of April the largest number of eggs ever obtained on any one night, up to that date, was secured at the Avoca Fishery, operated by Messrs. Gray & Capehart. William S. and Augustus Wroten, two of our operators, stripped

eighty-three (83) ripe female shad on the night of that day, all taken at one haul of the seine.

About this time we proceeded some ten miles up Salmon Creek in the steam launch, accompanied by Prof. James W. Milner, Deputy United States Commissioner, and Wm. Hamlen, one of the trained experts of the Maryland Commission. Near a mill-dam, which blocks the stream at this point, we secured three ripe female herring and several males, which were stripped and the eggs transported to the Hatching Station; these were successfully hatched by the 20th, and with inconsiderable loss. The eggs were found to be at first very adhesive, but after impregnation they became much less so, and were easily perfected in the cylinders used for hatching shad. The eggs of the herring being much smaller than those of the shad, it was found necessary to use wire cloth with a very much finer mesh. A number of these young fish were safely transported to Washington on board the Lookout, she having been dispatched on the 21st of April with 700,000 eggs and fish intended for Maryland. The steamer did not reach Washington until the 23d, having been detained in Hampton Roads by a severe storm. This unexpected detention in salt water caused the loss of most of the eggs and fish. Those surviving were placed in the Potomac River after reaching fresh water.

On the night of the 29th of April, 820,000 eggs were obtained at the fisheries surrounding the Hatching Station, and this was the last large lot of eggs procured on Albemarle Sound during the season. On the following day we secured some 80,000 herring eggs, which were also successfully hatched.

By May 1st most of the seines having "*cut out*," we commenced preparations for transferring the equipment to the head of the bay, and on the 2d the "Lookout" left with 700,000 eggs and 335,000 fish, which were intended for Maryland waters. The weather was exceedingly hot, and passing by Norfolk the water was renewed from a city hydrant, and very soon after the introduction of this water into the tank the fish commenced dying rapidly. It was unusually rough on the bay and in the Potomac River during our passage up to Washington, and this second attempt to transfer the fish

from Avoca to the waters of Maryland was also unsuccessful.

The barges were towed by the Revenue Cutter "Stevens" to Norfolk, where they were met by the "Ewing," and from thence taken to the head of the bay.

The large number of eggs which was obtained at the Salmon Creek Station, amounting to 10,342,000, is an evidence of the peculiar adaptability of this locality for shad hatching.

RECORD OF SHAD HATCHING OPERATIONS *conducted at Salmon Creek, States and Maryland Commissions,*

Date.	Temperature of									Wind.			
	Air.	Surface water.	Bottom.	Air.	Surface water.	Bottom.	Air.	Surface water.	Bottom.	Direction.	Intensity.	Direction.	Intensity.
	7 A. M.			12 M.			7 P. M.			7 A. M.		12 M.	
Mar. 28	...	...	...	69	60	...	...	...	...	.....	.....	S.W.	.....
" 29	...	...	...	69	60	...	...	...	...	.....	.....	N.E.	.....
" 30	...	...	...	60	60	...	...	...	...	.....	.....	N.E.	.....
" 31	...	...	...	75	62	...	...	...	...	.....	.....	S.W.	.....
April 1	...	...	...	62	63	...	...	...	...	.....	.....	N.W.	.....
" 2	...	...	...	74	61	...	...	...	...	.....	.....	N.E.E.	.....
" 3	...	...	...	65	61	...	...	...	...	.....	.....	E.N.E.	.....
" 4	...	...	...	53	60	58	...	...	...	.....	.....	N.E.	.....
" 5	...	...	...	63	58	57	...	...	...	.....	.....	N.N.W.	.....
" 6	...	...	...	56	57½	57	...	...	...	.....	.....	N.W.	.....
" 7	...	...	...	64	58½	57	...	...	...	.....	.....	W.	.....
" 8	...	...	...	62	61	58½	...	...	...	.....	.....	E.N.E.	.....
" 9	...	...	...	67	61	58½	...	...	...	.....	.....	S.E.E.	.....
" 10	...	...	...	64	60	58	...	...	...	.....	.....	.....	.....
" 11	63	61	58	68	64	58	65	63	58	W.	.....	N.E.	.....
" 12	54	59	58	77	63	60	64	61	59	W.S.W.	.....	W.	.....
" 13	69	62½	59	79	64	60	66	64	63	W.S.W.	.....	.....	.....
" 14	64	62	61	68	66	63½	60½	65½	63	N.E.E.	.....	E.	.....
" 15	60½	65	63	66½	66	62½	60½	65½	62	N.E.	.....	.....	.....
" 16	56	64	61	56	60½	60½	53	59	59½	N.N.W.	.....	N.N.W.	Strong.
" 17	56	59	56	64	60½	59	53	63	58	N.W.	.....	N.W.	.....
" 18	51	61	58	55	63	60	55	64	60½	.....	.....	.....	.....
" 19	58	62	59	72	64	60	61	66	60	.....	.....	.....	.....
" 20	60	61	60½	78	64	63	65	64	61½	.....	.....	.....	.....
" 21	69	64	62½	78	71	60½	68	70	61	.....	.....	.....	.....
" 22	65	65	62½	77	71	62½	75	72	63	.....	Calm.	.....	Calm.
" 23	70	66	62	79	70	66	75	67	65	.....	Light.	.....	Brisk.
" 24	72	66	62½	76	67	66	...	...	...	.....	Light.	.....	Brisk.
" 25	64	66	65	78	67	65	64	67	64½	.....	Light.	.....	Brisk.
" 26	64	65	64½	80	71	65½	...	...	...	.....	Calm.	.....	Light.
" 27	67	67	65	85	76	65½	77	70	68	.....	.....	.....	.....
" 28	65	70	67	80	76	68	68	70½	67½	.....	.....	.....	.....
" 29	59	67	67½	71	70	68½	60	69	69	.....	Calm.	.....	Slight.
" 30	70	70	67	81	72	67½	66	72	70	.....	Calm.	.....	Calm.
May 1	64	70	69	83	76	70	...	...	...	.....	Calm.	.....	Calm.

on the Albemarle Sound, from March 28th, 1878, to May 1st, 1878, on account of United by the Commissioners.

Direction	Intensity.	Condition of Sky. 7 A. M.	12 M.	7 P. M.	Water.	Ripe Fish Shad. Males.	Females.	Eggs Obtained	Fish Hatched.
7 P. M.									
.....	.....	.....	Cloudy	.....	Muddy.	2	2	16,000	.....
.....	.....	.....	Fair.	.....	Muddy.	...	...	.....	.....
.....	.....	.....	Cloudy.	.....	Muddy.	...	...	.....	.....
.....	.....	.....	Fair.	.....	Muddy.	...	...	.....	.....
.....	.....	.....	Fair.	.....	Muddy.	20	12	225,000	.....
.....	.....	.....	Fair.	.....	Muddy.	12	14	188,000	.....
.....	.....	.....	Cloudy.	.....	Muddy.	30	18	288,000	.....
.....	.....	.....	Cloudy.	.....	Muddy.	2	1	20,000	.....
.....	.....	.....	Clear	.....	Muddy.	2	1	20,000	.....
.....	.....	.....	Cloudy.	.....	Muddy.	9	6	120,000	2,500
.....	.....	.....	Clear.	.....	Muddy.	...	...	.....	.....
.....	.....	.....	Clear.	.....	Clear.	16	11	195,000	.....
.....	.....	.....	Cloudy.	.....	Clear.	...	13	240,000	.....
.....	.....	.....	Rainy	.....	Clear.	...	16	320,000	.....
S.W.	.....	Misty.	Clear.	Cloudy.	Clear.	...	5	100,000	250,000
.....	Calm.	Fair.	Clear.	Clear.	Clear.	...	8	140,000	625,000
W.	.....	Clear.	Clear.	Clear.	Clear.	...	19	380,000	.....
E.	.....	Hazy.	Hazy.	Hazy.	Clear.	...	...	.....	.....
.....	.....	Cloudy.	Cloudy.	Cloudy.	Clear.	...	83	1,605,000	*120,000
N.N.W.	Strong.	Cloudy.	Cloudy.	Cloudy.	Clear.	...	59	1,160,000	.....
.....	.....	Cloudy.	Cloudy.	Cloudy.	Clear.	...	...	.....	.....
.....	.....	.....	.....	.....	.....	...	76	1,465,000	.....
.....	.....	Clear.	Clear.	Fair.	Clear.	...	27	540,000	.....
.....	.....	Fair.	Cloudy.	Cloudy.	Clear.	...	8	145,000	840,000
.....	.....	Clear.	Clear.	Clear.	Clear.	...	...	.....	.....
.....	Fresh.	Clear.	Clear.	Clear.	Clear.	...	27	540,000	100,000
.....	Light.	Cloudy.	Cloudy.	Fair.	Clear.	...	31	610,000	320,000
.....	.....	Cloudy.	Cloudy.	.....	Clear.	...	1	20,000	1,000,000
.....	Calm.	Cloudy.	Cloudy.	Clear.	Clear.	...	22	440,000	520,000
.....	.....	.....	.....	.....	.....	...	4	80,000	475,000
.....	.....	.....	.....	Clear.	.....	...	20	400,000	.....
.....	Slight.	.....	.....	Fair.	Clear.	...	...	.....	300,000
.....	Calm.	.....	.....	.....	.....	...	40	820,000	178,000
.....	Calm.	Fair.	Fair.	Fair.	Clear.	...	...	165,000	165,000
.....	.....	Fair.	Fair.	.....	Clear.	...	...	100,000	100,000
							524	10,342,000	4,995,500

*Stripped three female herring, milt plentiful, at the mill, head of Salmon Creek.

RECORD OF SHAD HATCHING OPERATIONS *conducted on Steamer account of United States and Maryland Commissions,*

Date.	Temperature of						Wind.			
	Air.	Surface water.	Air.	Surface water.	Air.	Surface water.	Direction.	Intensity.	Direction.	Intensity.
	7 A. M.		12 M.		6 P. M.		7 A. M.		12 M.	
May 16	....	....	....	....	49	61	.....	.....	.....	.....
" 17	59	58½	....	....	....	....	S.S.W.	Fresh.	.....	.....
" 18	60	59	....	....	....	....	S.S.W.	Light.	.....	.....
" 19	59½	60	61	61½	60½	62	S.W.	Light.	S.	Fresh.
" 20	66½	62	62	62½	65	63½	S.	Light.	S.	Light.
" 21	66½	64	68	69	....	....	N.W.	Light.	S.	Light.
" 22	64	66	69	67	65	72	N.W.	Fresh.	N.W.	Fresh.
" 23	64	66	....	....	67	69	N.W.	Light.	.....	.....
" 24	66	66½	72	66½	68	66	.....	Calm.	S.E.	Fresh.
" 25	67	66	....	....	....	....	N.W.	Light.	.....	.....
" 29	....	....	....	....	63	72	.....	.....	.....	.....
" 30	66	70	85	72	69	73	S S.W.	Fresh.	S.S.W.	Fresh.
" 31	63	70	67	71	60	71	N.W.	Fresh.	N.W.	Fresh.
June 1	62	70	65	69	64	69	N.W.	Fresh.	N.	Gale.
" 2	64	68	65	68	66	68	N.N.E.	Fresh.	N.N.E.	Fresh.
" 3	67	67	....	....	72	70	N.E.	Light.	.....	.....

a. Four hauls a day averaging 100 shad, but none ripe.

b. Seine broke and fish escaped. Put 50,000 young shad in Neapsico Creek.

c. Steamer left Keystone Point at 10 A. M., went up to Chapman's fishery, found they were not fishing, returned and anchored near Indian Head.

d. Moved to Washington, D. C. and anchored off 8th st. wharf.

Lookout, on the Potomac River, from May 16th, 1878, to June 3d, 1878, on by H. C. Chester, Master of Steamer Lookout.

Condition of						Ripe Female Fish.	Eggs Obtained.
Direction.	Intensity.	Sky.			Water.		
6 P. M.		7 A. M.	12 M.	6 P. M.			
N.W.	Fresh.	.....	.....	Clear.	Roily.	....	.....
.....	.....	Cloudy.	.....	.....	Roily.	....	*a*.....
.....	.....	Clear.	.....	.....	Clear.	....	*a*.....
S.E.	Light.	Clear.	Cloudy.	Cloudy.	Clear.	3	50,000
S.	Light.	Cloudy.	Cloudy.	Clear.	Roily.	4	70,000
W.	Light.	Clear.	Clear.	Clear.	Clear.	1	20,000
N.N.W.	Light.	Clear.	Clear.	Clear.	.....	2	*b* 40,000
.....	Calm.	Clear.	.....	Clear.	Clear.	19	*c* 400,000
.....	Calm.	Cloudy.	Cloudy.	Cloudy.	Clear.	29	500,000
.....	.....	Cloudy.	.....	.....	Clear.	11	*d* 220,000
W.	Light.	.....	.....	Clear.	Clear.	3	*e* 60,000
							f 50,000
N.	Strong.	Clear.	Clear.	Rain.	.....	....	*g*.....
N.W.	Fresh.	Cloudy.	Cloudy.	Cloudy.	Roily.	....	*h*.....
N.	Fresh.	Cloudy.	Cloudy.	Cloudy.	.....	....	*i*.....
N.N.E.	Fresh.	Cloudy.	Cloudy.	Cloudy.	.....	....	*k* 20,000
E.	Light.	Cloudy.	.....	Clear.	.....	...	.....
						72	1,430,000

e. Taken from gillers.

f. Taken at Glymont.

g. Heavy squalls from N. and N. W., over 100,000 eggs lost from the wooden boxes.

h. High Point. Heavy squall with rain from N. W. at 4 P. M.

i. Last haul of the season.

k. Taken from gillers.

The "Lookout" having deposited in the Potomac River the fish surviving from the lot of fish and eggs taken from the Albemarle Sound Hatching Station on the 2d, proceeded to Havre-de-Grace, reaching there on the night of the 6th.

One of the Maryland Commissioners having been appointed by the President Commissioner to the Paris Exposition, with instructions to examine and report on fish culture, the conduct of the shad hatching was turned over to Prof. James W. Milner, Deputy United States Commissioner, who had been associated with us on Albemarle Sound, during the previous season, and at the head of the bay, he having had charge of the department of distribution. Prof. Milner having kindly consented to take chage of the hatching department, we felt satisfied that the work in Maryland would be pushed forward with vigor and intelligence.

The season was exceedingly backward, as the spring continued unusually cold. A few eggs, however, were secured on the 7th of May. On the 15th day of May the "Lookout" was dispatched to attend the fisheries on the Potomac River, having on board a crew of experts in shad hatching. A statement of the operations conducted on the Potomac will be found in the preceding table.

We are indebted to Prof. Milner for many courtesies, and for the detail of some of his trained fish transporters, who rendered valuable assistance in taking the young shad to rivers of the State.

On the 20th, 520,000 eggs were obtained from the gill-nets at the Head of the Bay; this was the first night on which any considerable number of eggs were secured. The yield of eggs from the 20th to the 29th showed a gradual increase, until, on the latter date, the largest number of eggs ever taken on one night was gathered, exceeding in number the best night's work in Albemarle Sound; 97 female shad were stripped, from which were secured 1,940,760 eggs, being 335,000 eggs more than obtained on the night of April 15, when 83 yielded 1,605,000. One million and a half of young shad (1,500,000), were liberated in the Susquehanna River on this day, and on the 1st of June 500,000 more were put into the same stream.

On the 14th of June, the fishing season having closed, the last shipment was made from the station at Spesutie Narrows; this consisted of 80,000, which were deposited in the Gunpowder River.

On the 17th, the eggs having all hatched, the station was abandoned for the season, and the equipment sent to the Washington Navy Yard.

RECORD OF SHAD HATCHING OPERATIONS *conducted at Havre de Grace, Md., on the Susquehanna River, from May 7, 1878, to June 12, 1878, on account of United States and Maryland Commissions, by the Commissioners.*

Date.	Temperature of									Wind.			Condition of						
	Air.	Surface water.	Bottom.	Air.	Surface water.	Bottom.	Air.	Surface water.	Bottom.	Intensity.	Intensity.	Intensity.	Sky.			Water	Ripe Female Fish.	Eggs Obtained.
	7 A. M.			12 M.			8 P. M.			7 A. M.	12 M.	8 P. M.	7 A. M.	12 M.	8 P. M			
May 7	...	....	....	....	....	....	....	....	....	.....	.....	.....	.....	.....	.....	.....	....	25,000
" 8	...	....	....	....	....	....	....	....	....	.....	.....	.....	.....	.....	.....	.....	....	145,000
" 9	...	....	....	....	....	....	....	....	....	.....	.....	.....	.....	.....	.....	.....	....	130,000
" 10	...	....	....	....	....	....	....	....	....	.....	.....	.....	.....	.....	.....	.....	....	85,000
" 12	...	....	....	....	....	....	56	61½	...	.....	.....	Calm	.....	.....	Cloudy	Clear	....	.....
" 13	50	58	57	59	62	59	53	60	58	Strong.	Fresh .	Slight..	Hazy..	Fair...	Cloudy	Roily	....	60,000
" 14	50	59	57½	51½	59	57½	50	57	57½	Slight..	Calm ..	Fresh .	Cloudy	Cloudy	Cloudy	Roily	....	20,000
" 15	46	56	56½	52	56½	55	53½	57	55	Fresh .	Fresh .	Calm ..	Cloudy	Cloudy	Fair...	Roily	3	60,000
" 16	53	56½	55½	61	62	57	60	59½	57	Fresh .	Slight .	Slight	Fair...	Cloudy	Cloudy	Roily	....	.....
" 17	59	60	57	60	61	57	57	60	57	Slight .	Slight .	Slight .	Cloudy	Cloudy	Cloudy	Roily	7	150,000
" 18	57	59½	57½	.....	.....	.....	62	65½	62	Calm ..	.....	Slight .	Fair...	.....	Clear..	Roily	2	40,000
" 19	61	60	59	70	64	63	60	63½	63	Slight .	Slight..	Slight .	Fair...	Clear..	Fair..	Roily	3	60,000
" 20	60	63½	63	65½	64	63	64	64½	63	Slight .	Slight..	Strong.	Cloudy	Cloudy	Cloudy	Clear	26	520,000
" 21	66	64½	63	73	68	63½	.....	.....	.....	Fresh .	Calm ..	.....	Cloudy	Fair...	.....	Clear	29	580,000
" 22	57	63	62½	64	65	65	66½	67½	65	Fresh .	Fresh .	Slight .	Fair...	Clear..	Clear..	Roily	31	620,000
" 23	...	....	....	....	....	....	....	....	....	.....	.....	.....	.....	.....	.....	.....	23	470,000
" 24	70	67½	65	73	70	66	66½	68	66	Calm ..	Calm ..	Calm ..	Cloudy	Cloudy	Cloudy	Clear	44	880,000
" 25	65	68	65½	74	70½	67	....	....	....	Calm ..	Calm ..	.....	Cloudy	Cloudy	.....	Clear	27	540,000

RECORD OF SHAD HATCHING OPERATIONS *conducted at Havre de Grace, Md., on the Susquehanna River, from May 7, 1878, to June 12, 1878, on account of United States and Maryland Commissions, by the Commissioners*—Continued.

Date.	Temperature of									Wind.			Condition of					
	Air.	Surface water.	Bottom.	Air.	Surface water.	Bottom	Air.	Surface water.	Bottom.	Intensity.	Intensity.	Intensity.	Sky.			Water	Ripe Female Fish.	Eggs Obtained.
	7 A. M.			12 M.			8 P. M.			7 A. M	12 M.	8 P. M.	7 A. M.	12 M.	8 P. M.			
May 26.	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....	.....	.....	38	760,000
" 27.	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....	.....	.....	65	1,300,000
" 28.	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....	.....	.....	71	1,430,000
" 29.	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....	.....	.....	97	1,940,000
June 1.	...	...	...	...	...	...	...	...	...	Gale .	Gale...	Gale...	Cloudy	Cloudy	Cloudy	Roily	....	.....
" 2.	70	66	63	72	66	63	70	65½	63	Strong	Fresh .	Slight..	Cloudy	Cloudy	Cloudy	Roily	4	80,000
" 3.	69	65	63	70½	67½	65	68	71	67	Slight..	Slight..	Calm ..	Cloudy	Fair ...	Clear ..	Clear	53	1,060,000
" 4.	71	69	66	76	69	66½	74	72	68	Slight..	Slight..	Fresh..	Cloudy	Fair ...	Cloudy	Clear	40	750,000
" 5.	72	71	68	77	72	69½	66	72	69	Fresh .	Fresh .	Strong	Fair ..	Cloudy	Clear .	Clear	....	.....
" 6.	62	68½	66	66	74	71	65	74	71	Strong	Fresh .	Calm ..	Hazy .	Hazy ..	Clear ..	Roily	20	300,000
" 7.	66	72	69	73	74	72	69	72	70	Slight..	Slight..	Fresh .	Clear .	Fair ...	Hazy ..	Roily	12	200,000
" 8.	70	71	68	....	..	..	72	70½	68	Slight .	.....	Slight .	Cloudy	.....	Cloudy	Clear	8	120,000
" 9.	68	70	67	72	72	70	65	73	70	Fresh .	Slight..	Calm ..	Cloudy	Fair ...	Cloudy	Clear	12	200,000
" 10.	65	71	68	69	72	69	....	....	..	Calm ..	Slight..	.....	Cloudy	Cloudy	.....	Clear	7	125,000
" 11.	...	...	...	...	...	...	66	70	68½	.....	.....	Fresh .	.....	.....	Fair....	Clear	5	80,000
" 12.	63½	68½	66	....	....	....	....	....	....	Slight..	.....	.....	Hazy ..	.....	.....	Clear	....	.....
																	627	12,730,000

The steamer "Lookout" having been sent from Spesutie Narrows to the Potomac River on the 15th of May, commenced attending the fisheries the following day, but no eggs were obtained until the night of the 19th; these were hatched by the 23d and the fish turned into the Potomac. On the 25th she secured a million of shad eggs and 150,000 herring eggs. These being as many as could be well cared for in the hatching apparatus, she proceeded to the Washington Navy Yard, where she lay safely at anchor until the fish were hatched. On the 28th she again proceeded down the river for the purpose of collecting another supply.

The season having pretty well closed on the Potomac, she returned to Washington on the 4th of June, and the crew were discharged, the steamer laid up at the Navy Yard, and there cared for by the United States Commission until the 1st of October.

This ended our shad hatching operations for the spring of 1878, which was most successful.

It will be found by an examination of the tables showing the details of the work, that the total number of eggs gathered in Albemarle Sound was 10,342,000, at the head of the bay, 12,730,000, and on the Potomac River, 1,430,000, making a grand total of 24,502,000 From these 15,546,500 of fish were produced, and 7,935,000 were placed in Maryland waters, exclusive of 200,000, which were placed in the headwaters of the Potomac River by the Commissioner for Virginia.

RECORD OF DISTRIBUTION OF SHAD *made from April 21, 1878, to June 15, 1878, by Maryland Commission of Fisheries, under direction of the Commissioners.*

Date of Transfer.	Obtained from—	Place whence taken.	No. of Fish. Orig'l'y Taken.	No. of Fish. Actually Planted.	Introduction of Fish. Town or Place.	Stream.	Tributary of—	Transfer in charge of—
April 21.	Seine hauls.....	Salmon Creek..	700,000	100,000	Navy Yard	Potomac River...	Chesapeake Bay	T. B Ferguson.
*			700,000 Eggs.					
May 1..	Seine hauls.....	Salmon Creek..	[illegible]	100,000	Whitestone Pt.	Potomac River..	Chesapeake Bay	T. B. Ferguson.
May 17.	Gillers.....	Havre de Grace.	100,000	100,000	Greensborough.	Choptank River..	Chesapeake Bay	Thos. Hughlett.
May 23.	Freestone Point	Str. Lookout..	50,000	50,000	Neapsico Creek	Potomac River...	Chesapeake Bay	Capt. H. C. Chester.
May 23.	Freestone Point	Str. Lookout..	50,000	50,000	Freestone.....	Potomac River...	Chesapeake Bay	Capt. H. C. Chester.
May 24.	Freestone Point	Str. Lookout..	75,000	75,000	Glymont.....	Potomac River...	Chesapeake Bay	Capt. H. C. Chester.
May 24.	Gillers.....	Havre de Grace.	160,000	160,000	Fallingtown ..	Nanticoke River..	Chesapeake Bay	Thos. Hughlett.
May 25.	Gillers.....	Havre de Grace.	150,000	150,000	Havre de Grace.	Susquehanna Riv	Chesapeake Bay	Md. & U. S. F. Com.
May 26	Gillers.....	Havre de Grace	250,000	250,000	Bull's Mountain	Susquehanna Riv.	Chesapeake Bay	Md. & U. S. F. Com.
May 26.	Gillers.....	Havre de Grace.	100,000	100,000	Havre de Grace.	Susquehanna Riv.	Chesapeake Bay	Md & U. S. F. Com.
May 27.	Gillers.....	Havre de Grace.	200,000	200,000	Havre de Grace.	Susquehanna Riv.	Chesapeake Bay	Md. & U. S. F. Com.
May 27.	High Point, ...	Str. Lookout...	400,000	400,000	Washingt'n D C	Potomac River...	Chesapeake Bay	Md. & U. S. F. Com.
May 28.	High Point.....	Str. Lookout...	200,000	200,000	Riverton, Va...	Shenandoah River	Potomac River.	W. F. Page.
May 28.	High Point.....	Str. Lookout...	100,000	100,000	Ft. Washington	Potomac River..	Chesapeake Bay	Md. & U. S. F. Com.
May 28.	High Point.....	Str. Lookout...	300,000	300,000	Glymont.....	Potomac River..	Chesapeake Bay	Md. & U. S. F. Com.
May 28.	Gillers.....	Havre de Grace.	400,000	400,000	Havre de Grace.	Susquehanna Riv.	Chesapeake Bay	Md. & U. S. F. Com.
May 29.	Gillers.....	Havre de Grace	175,000	175,000	Salisbury	Wicomico River..	Chesapeake Bay	Thos. Hughlett.
May 29.	Gillers.....	Havre de Grace.	75,000	75,000	Princess Anne..	Manokin River...	Tangier Sound.	Thos. Hughlett.
May 29.	Gillers.....	Havre de Grace.	1,500,000	1,500,000	Havre de Grace.	Susquehanna Riv.	Chesapeake Bay	Md. & U. S. F. Com.

* Most of these eggs and fish were lost on board the steamer Lookout, as she was detained in Hampton Roads by storm, and the water taken on at Norfolk proved very injurious.

RECORD OF DISTRIBUTION OF SHAD *made from April* 21, 1878, *to June* 15, 1878, *by Maryland Commission of Fisheries, under direction of the Commissioners*—Continued.

Date of Transfer.	Obtained from—	Place whence taken.	No. of Fish.		Introduction of Fish.			Transfer in charge of—
			Orignl'y Taken.	Actually Planted.	Town or Place.	Stream.	Tributary of—	
May 30.	Gil'ers.....	Havre de Grace.	500,000	500,000	Havre de Grace.	Susquehanna Riv	Chesapeake Bay	Md. & U. S. F. Com.
May 31.	Gillers.....	Havre de Grace.	250,000	250,000	Millington	Chester River....	Chesapeake Bay	Thos. Hughlett.
June 1..	Gillers.....	Havre de Grace.	50,000	50,000	Easton	Tread Haven Riv.	Chesapeake Bay	S. M. Rixey.
June 1..	Gillers.....	Havre de Grace.	75,000	75,000	Near Easton...	Miles River.....	Eastern Bay. ..	S. M. Rixey.
June 1 .	Gillers	Havre de Grace.	500,000	500,000	Havre de Grace.	Susquehanna Riv.	Chesapeake Bay	Md. & U. S. F. Com.
June 3..	Gillers	Havre de Grace	500,000	500,000	Havre de Grace	Susquehanna Riv.	Chesapeake Bay	Md. & U. S. F. Com.
June 3.	Gillers	Havre de Grace	100,000	100,000	Greensborough.	Choptank River..	Chesapeake Bay	Thos. Hughlett.
June 3..	Gillers.....	Havre de Grace.	50,000	50,000	Hillsborough...	Tuckahoe River..	Chesapeake Bay	S. M. Rixey.
June 4 .	Gillers	Havre de Grace.	150,000	150,000	Waynesboro'Va	South River.....	Shenandoah R..	W. F. Page.
June 5..	Gillers..... ...	Havre de Grace.	150,000	150,000	Laurel.	Patuxent River...	Chesapeake Bay	J. M. Donaldson.
June 6..	Gillers	Havre de Grace.	150,000	150,000	Laurel.	Patuxent River...	Chesapeake Bay	David Scott.
June 6..	Gillers.....	Havre de Grace.	500,000	500,000	Havre de Grace.	Susquehanna Riv.	Chesapeake Bay	Md. & U. S. F. Com.
June 10.	Gillers.....	Havre de Grace.	150,000	150,000	Snow Hill.....	Pocomoke River..	Chesapeake Bay	S. M. Rixey.
June 10.	Gillers.....	Havre de Grace.	150,000	150,000	R. R. Crossing.	Bush River.....	Chesapeake Bay	W. F. Page.
June 10.	Gillers.	Havre de Grace.	100,000	100,000	Havre de Grace.	Susquehanna Riv.	Chesapeake Bay	Md. & U. S. F. Com.
June 11.	Gillers	Havre de Grace	185,000	185,000	Havre de Grace	Susquehanna Riv.	Chesapeake Bay	Md. & U. S. F. Com.
June 14	Gillers.....	Havre de Grace.	120,000	120,000	Havre de Grace.	Susquehanna Riv.	Chesapeake Bay	Md. & U. S. F. Com.
June 14.	Gillers.....	Havre de Grace.	80,000	80,000	Cockeysville ...	Gunpowder River.	Chesapeake Bay	Newton Simmons.
			9,820,000	8,285,000				

Carp—(*Cyprinus carpio*).

The arrival of the third importation of European carp was referred to on page 31 of our last report. To provide for these additional fish, and in order to keep the varieties isolated as much as possible, we determined to devote the appropriation of one thousand dollars made by the City Council of Baltimore for the extension of the ponds in the park, to the construction of three additional lakes for the carp; these were admirably laid out by and constructed under the superintendence of Mr. Augustus Faul, the engineer of Druid Hill Park.

Congress having made an appropriation for the purpose of preparing the two lakes between the President's House and Potomac River, for the reception and cultivation of the imported carp, they were fitted up in a manner admirably adapted for the purpose. Prof. Baird therefore determined to remove a portion of the fish from Druid Hill Park to these ponds, leaving an ample supply of breeding fish for the ponds in our charge. At his request we had the ponds drawn in the early part of May and sent to him 13 golden ide, 13 king tench, 47 scale carp and 100 leather carp: this left for the Baltimore ponds 32 leather carp, 37 golden ide, 56 scale carp and 19 mirror carp. On drawing the ponds in Baltimore, we found 1758 hybrid carp, the result of a cross between the common gold fish and the carp, the latter evidently having worked their way into the ponds from the high service reservoir. We deemed it advisable to get rid of these, as in our limited ponds we preferred to cultivate only the true carp, and those of the best varieties. The hybrids were accordingly shipped to Washington.

The new ponds being ready to receive the fish in the early part of December, we transferred the scale *carp*, ranging from five to seventeen inches long, to pond No. 4, the largest of the new series; the *golden ide* were retained in the old pond in which they had previously been, the *small scale carp* ranging from one and a half to five inches in length were placed in No. 3, and No. 5 was reserved for the *mirror carp*.

Thus it will be seen that we now have a sufficient stock to supply the whole State if we are successful in their cultivation. These are distributed as follows:

Thirty-two leather carp in pond No. 1.

Twenty-nine golden ide in pond No. 2.

Three hundred and ninety-eight small scale carp in pond No. 3.

Ninety-eight adult scale carp in pond No. 4.

Eight mirror carp in pond No. 5.

There are, in addition to these five ponds, three small ponds which are intended for hatching and caring for the young fish when they are propagated from spawn taken artificially.

During the construction of the new lakes, the original ponds in which the carp were kept accidently overflowed their banks and many of the small fish and some adults made their escape; these, no doubt, have gone into the ponds of Messrs. Poole & Hunt, and from thence into Jones Falls. This stream has no doubt been well stocked by this accident.

As the carp is very prolific, it is confidently expected that in the next few years we will be able to distribute a large number to the various parts of the State where there are ponds suitable for the culture of this character of fish and not adapted for raising trout, or other fish which require cold, pure water, and an abundant supply of animal food.

Conclusion.

As the General Assembly will not convene until a year from this time, we will reserve any suggestions for the protection and propagation of food fishes until our next report, which will embody the transactions of the Commission during the year 1879. We beg to here renew our thanks to the several railroad and steamboat lines for their continued co-operation and great services rendered to the Commission.

Respectfully submitted,

T. B. FERGUSON,
THOMAS HUGHLETT,
Commissioners.

PUBLIC GENERAL LAWS

ON

Fish and Fisheries.

FISH AND FISHERIES.

PUBLIC GENERAL LAWS.

Chapter 276 *Laws of* 1878, *repeals Chapter* 252 *Laws of* 1876, *which repealed* 421 *Laws of* 1874, *which repealed Section* 2 *of Article* 41 *of Public General Laws of Maryland, title "Fish and Fisheries," and re-enacts the same with Amendments.*

Laws of 1878, *Chapter* 276, *Sections* 1, 2, 3.

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That the act passed at the session of the General Assembly of Maryland, eighteen hundred and seventy-six, chapter two hundred and fifty-two, entitled "An act to repeal an act passed at the session of the General Assembly of Maryland in eighteen hundred and seventy-four, chapter four hundred and twenty-one of the Public General Laws of Maryland, title 'Fish and Fisheries,'" and to re-enact the same with amendments, and to substitute the following in lieu thereof, be and the same is hereby repealed, amended and re-enacted so as to read as follows:

Repealed, amended and re-enacted.

SEC. 1. No person shall, from the tenth day of June to the first day of September of each year, fish with hauling seine or seines of any kind within the Chesapeake Bay or any of its tributaries lying northward of the following line, viz: Beginning at the light-house on Turkey Point, in Cecil county, and drawn westward to the most northerly point of Spesutia Island, in Harford county.

Hauling seines prohibited.

SEC. 2. *And be it enacted*, That any person or persons violating any of the provisions of this act, upon conviction thereof before any justice of the peace of the county in which said act has been violated, shall pay a fine of thirty dollars, and forfeit such seine or seines and the boat or boats and materials used in fishing the same, and upon trial and conviction, the seine or seines, boat or boats, and other fixtures used

Penalty for violation.

by said offender or offenders, shall be forfeited and sold to the highest bidder by the proper authorities, and the proceeds, together with the fine, after deducting the costs, shall be paid to the County Commissioners of the county in which said offence shall be committed, for the use of the school fund of said county.

Sec. 3. *And be it enacted*, That any person or persons, on conviction, failing to pay the fine, as prescribed in the preceding section, shall be imprisoned in the county jail of the county in which said offence shall be committed; provided, however, that any one so offending shall, upon conviction before any justice of the peace of the county in which said offence was committed, have the right of appeal to the Circuit Court of the county in which said offence shall be committed, under the same restrictions governing appeals from the decisions of justices of the peace.

Right of appeal.

Sec. 2. *And be it enacted*, That this act shall take effect from the date of its passage.

In force.

Chapter 363 *Laws of* 1878, *amends and adds sub-sections to Chapter* 219 *Laws of* 1874, *which amended Section* 22, *Article* 41, *of the Code of Public General Laws, entitled "Fish and Fisheries," sub-title "Patuxent."*

Laws of 1878, *Chapter* 363, *Section* 1, *Sub-Sections* 3 *and* 4.

Section 1. *Be it enacted by the General Assembly of Maryland*, That section twenty-two of article forty-one of the Code of Public General Laws, title "Fish and Fisheries," sub-title "Patuxent," regulating the right of Fishing in the Patuxent river and its tributaries, as amended by the act of eighteen hundred and seventy-four, chapter two hundred and nineteen, be and the same is hereby amended by adding the following sub-sections thereto:

Amended.

Sub-Sec. 3. It shall not be lawful for any person or persons whatsoever to haul in the waters of the Patuxent river, between Sheridan's point and Point Patience, any seine of greater length than sixty fathoms, at any time between the first day of June and the first day of October following.

When unlawful.

SUB-SEC. 4. Any person violating the provisions of this last-mentioned section shall be deemed guilty of a misdemeanor, and upon conviction thereof before a justice of the peace for Calvert county, or before the Circuit Court of Calvert county, shall be fined a sum not less than twenty dollars nor more than fifty dollars, one half thereof to be paid to the informer and the other half thereof to the County Commissioners of said county. May be fined.

SEC. 2. *And be it enacted*, That this act shall take effect from the date of its passage. In force.

Chapter 424 *Laws* 1878, *protects Terrapins in State of Maryland.*

Laws of 1878, *Chapter* 424, *Sections* 1, 2, 3, 4, 5, 6 *and* 7.

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That hereafter it shall be unlawful for any person to take or catch diamond-back terrapins from the waters of this State between the first day of April and the first day of November in each year. When unlawful.

SEC. 2. *Be it enacted*, That it shall be unlawful for any person or persons to take or catch from the waters of this State any diamond-back terrapin of a less size than five inches in length, upon the bottom shell, at any time. Size to take

SEC. 3. *Be it enacted*, That it shall be unlawful for any person to interfere with, or in any manner detroy, the diamond-back terrapin eggs. Not to destroy eggs.

SEC. 4. *Be it enacted*, That none but *bona fide* citizens of the counties of this State bordering upon the waters of the same shall take or catch diamond-back terrapins from said waters. Who shall catch.

SEC. 5. *Be it enacted*, That any person or persons violating the provisions of this act, shall be deemed guilty of a misdemeanor, and upon conviction of the same, before a justice of the peace in the county in which the offence shall have been committed, he, she or they shall be fined a sum not less than five nor more than ten dollars for each diamond-back terrapin so taken or caught, or for destroying any diamond-back terrapin eggs, one-half of said fine to go Penalty for violation.

to the informer and the balance to be paid over by the said justice of the peace to the County Commissioners of said county, to be by them disbursed for the benefit of said county; said fine to be collected as other fines and forfeitures are now collected.

Possession evidence of violation.

SEC. 6. *Be it enacted*, That the possession of any diamond-back terrapin by any person or persons within the time prescribed by this act, prohibiting the taking and catching of the same, shall be deemed *prima facia* evidence that said person or persons have violated the provisions of this act.

Constables to arrest.

SEC. 7. *Be it enacted*, That the constables of the several counties of this State shall, upon the information of any one, arrest all persons violating the provisions of this act, and carry them before the nearest justice of the peace of the county wherein such offence shall have been committed, to be dealt with in accordance with the provisions of section five of this act.

PUBLIC LOCAL LAWS

ON

Fish and Fisheries.

FISH AND FISHERIES.

PUBLIC LOCAL LAWS.

ANNE ARUNDEL COUNTY.

Laws of 1878, *Chapter* 184, *Sections* 1, 2 *and* 3.

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That no person shall hunt, take, kill or destroy in any manner within the limits of Anne Arundel county, or in the waters of the Chesapeake Bay adjacent to said county in this State, any terrapins or terrapin eggs from the first day of May to the fifteenth day of October in any year.

No person shall hunt, &c., terrapins or terrapin eggs.

SEC. 2. *Be it enacted*, That if any person shall hunt, take, kill or destroy in any manner terrapins or terrapin eggs from the first day of May to the fifteenth day of October in any year, contrary to the provisions of this act, such person shall be guilty of a misdemeanor, and upon conviction thereof before any justice of the peace for said county shall be punished by a fine of not less than five dollars nor more than twenty dollars, one-half thereof to the informer and the other half to the school fund for Anne Arundel county.

Penalty.

SEC. 3. *And be it enacted*, That the possession by any person of any terrapins or terrapin eggs during the time prohibited by this act shall be *prima facia* evidence of the violation of this act by said person.

Evidence to convict.

BALTIMORE COUNTY.

Laws of 1878, *Chapter* 199, *Sections* 1, 2 *and* 3.

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That it shall not be lawful for any person or persons to take, catch or kill any speckled or brook trout, either by angling or the capture by the use of hook and line, spearing, fish basket or

Not lawful

To capture trout.

fish weirs, seines, gill-nets, pound-nets, purse-seine, or any other device known to capture trout, for the space of three years from the first of August, eighteen hundred and seventy-eight, in any branch, brook, creek or stream of water which has been or may be stocked with trout in Baltimore county.

Penalty.

SEC. 2. *And be it enacted*, That any person or persons found guilty of violating any provision of this act shall, upon conviction, be fined twenty dollars and costs, and in default of payment shall be confined in the county jail for not less than ten nor more than thirty days.

May be prosecuted

SEC. 3. *And be it enacted*, That the violation of any of the provisions of this act may be prosecuted by any citizen of the county before a justice of the peace for said county, subject to an appeal to the Circuit Court for said county, the informer to be a competent witness. Fines paid shall be equally divided between the informer and the Fish Commission of the State of Maryland.

Fines divided.

Laws of 1878, *Chapter* 242, *Sections* 1, 2 *and* 3.

Not lawful to fish within one mile of entrance.

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That it shall not be lawful for any person or persons to fish in the waters of Gunpowder river, Middle river or Back river, or their tributary streams, except Bird river, or in the waters of the Chesapeake Bay within one mile of the entrance of said rivers into the same situated in Baltimore county, with seine or nets, except from the shore in the usual and customary manner.

Not lawful to fish with fastened nets.

SEC. 2. *And be it enacted*, That it shall not be lawful for any person or persons to fish in said water, Bird river excepted, with nets fastened to stakes, commonly known as pound or trap nets.

Shall issue warant

SEC. 3. *And be it enacted*, That upon information given upon oath or affirmation to any justice of the peace having jurisdiction of any violation of any of the provisions of this act, he shall issue his warrant for the arrest of the offender or offenders, and for the seizure of the seines, nets, boats and other fishing outfit, to be directed to the sheriff or any constable of the county or other officer authorized to make arrests, or any citizen, and it shall be the duty of any sheriff, constable or other officer authorized

to make arrests, or citizens, upon receipt of said warrant, to arrest any person or persons violating the provisions of this act, and to seize any such seine, net, boat or other fishing outfit and found being used in violating any of said provisions, and to bring such offender or offenders before a justice of the peace most accessible or convenient, and upon conviction thereof the said offender or offenders shall be fined not less than twenty dollars nor more than two hundred dollars, one-half of such fine to be paid to the use of the informer, and the other half to the use of the public schools of the county in which said offence was committed, and shall forfeit the seine or net, boat and other outfit used in such fishing, which shall be sold and the proceeds divided in the same manner, and in case of non-payment of the fine and costs imposed by said justice, the said offender or offenders shall be confined in the county jail for a period not exceeding forty days and not less than twenty days, or until said fine and costs are paid.

Arrest any person.

Penalty.

Confined in jail.

SEC. 4. *And be it enacted*, That any person or persons who may feel himself or themselves aggrieved by any judgment rendered by a justice of the peace under the provision of this act shall have the right to appeal to the Circuit Court of the county where the act was committed, upon the condition and subject to the regulations now provided by the general law regulating appeals from justices of the peace, but execution of the judgment of the justice of the peace shall not be stayed unless the party appealing shall give bond to the State for double the amount of fine imposed, with security approved by the justice rendering the judgment, with conditions to prosecute his appeal with effect or to pay the fine imposed with all costs.

Any person feeling aggrieved.

May appeal

Give bond.

SEC. 5. *And be it enacted*, That nothing in this act shall pertain to the waters of Harford county.

Not pertain to Harford co.

CARROLL AND FREDERICK COUNTIES.

Laws of 1878, *Chapter* 112, *Sections* 1, 2 *and* 3.

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That it shall be unlawful for any person or persons to take, catch or destroy any fish

Shall be unlawful.

in the waters of Frederick or Carroll counties, except with hook and line, or by use of the dip net; provided that the Potomac river shall be exempted from the provisions of this act

SEC. 2. *And be it enacted*, That any one violating the provisions of the preceding section shall, upon conviction before a justice of the peace of said counties, be liable to a fine of not less than five dollars nor more than ten dollars for each offence, and upon failing to pay said fine and the cost of prosecution shall be sentenced to imprisonment in the county jail of the county in which the offence has been committed for a period not exceeding ten days; said fine to be paid to the County Commissioners for the use of the county.

Penalty.

SEC. 3. *And be it enacted*, That this act shall take effect from the date of its passage, and remain in force for two years.

In force.

CECIL COUNTY.

Laws of 1878, *Chapter* 449, *Sections* 1, 2 *and* 3.

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That it shall not be lawful for any person to lash or beat the waters of the Elk river, within the bounds of Cecil county, with rods, poles, sticks, or in any other manner, or to make noises on the decks of any boat or boats, or on any part of said boat, by the use of clogs or wooden shoes, or any other instrument, or by any other means, or in any other manner, for the purpose of driving fish into any seine, fish basket, or other contrivance for catching fish, or for the purpose or which will have the effect of driving or frightening wild water fowl of any description from their feeding or roosting grounds in the waters aforesaid, northward of a line drawn across said river from Court House Point on the east side to Oldfield's Point on the west side of said river.

What is unlawful.

SEC. 2. *And be it enacted*, That any person violating any of the provisions of the preceding section shall, on conviction thereof, pay a fine of not less than ten nor more than one hundred dollars.

Fine for violation.

SEC. 3. *And be it enacted*, That on information being given on oath to a justice of the peace of said

county that a violation of the first section has been or is being committed by any person, he shall forthwith issue his warrant for the arrest of the offender or offenders, which warrant shall be directed to the sheriff or some constable of said county, and such officer may summon the *posse comitatus* to aid him in making any arrest under this act. Arrest for violation.

SEC. 4. *And be it enacted*, That upon the arrest of the offender or offenders, he or they shall be taken before some justice of the peace of said county adjacent to the waters in which the offence was or is being committed, and if upon a hearing he shall be deemed guilty, shall pay a fine of not less than ten nor more than one hundred dollars, to be recovered as other small debts are recovered; and all fines imposed under this act shall be divided as follows: One-half to the officer making the arrest, and the other half to be divided equally between the persons aiding in making the arrest and the informer. Fines—how disposed of.

SEC. 5. *And be it enacted*, That any person who has been adjudged guilty of a violation of any of the provisons of this act, and feels himself aggrieved, shall have the right of appeal to the Circuit Court for the said county, on giving bond with two sufficient securities, to be approved of by the justice, to the State of Maryland, with condition to prosecute such appeal with effect to the Circuit Court, at its next session thereafter, and to pay the fine imposed and all costs attending such proceedings in case judgment shall be confirmed. Right of appeal.

CHARLES COUNTY.

Laws of 1878, *Chapter* 502, *Sections* 1, 2, 3 *and* 4.

SECTION 1. That it shall not be lawful for any person or persons, except *bona fide* citizens of Charles county, to take or catch fish or terrapins, or to haul a seine, or fish a gill net, or take or catch fish or terrapins in any manner in the Potomac River or its tributaries, or in the Wicomico River or its tributaries, lying in Charles county, between Maryland Point in Charles county and Chisildine's Island in St. Mary's county. Unlawful to catch fish, &c.

SEC. 2. That no person or persons shall haul a seine more than one hundred and sixty fathoms in Length of seine.

length in the Potomac River or its tributaries, nor in the Wicomico River or its tributaries, between Maryland Point in Charles county and Chisildine's Island in St. Mary's county, except from the fifteenth day of March to the first day of June, inclusive.

Size of meshes.

SEC. 2. *Be it enacted*, That no person or persons shall haul a seine, nor fish a net of any kind or description, with a mesh of less size than three inches, as provided in section two of this act as amended above; and provided, a license of one cent per lineal fathom on all traps, seines or nets of any description shall be paid to the clerk of Charles county before the same can be used for fishing.

Oyster police to supervise.

SEC. 3. *Be it enacted*, That the oyster police boat for the sixth district is hereby directed and empowered to supervise the fisheries in the said waters of the Potomac and its tributaries, and the Wicomico and its tributaries in Charles county, between the first day of June and the fifteenth day of March in each year, and upon information being conveyed to the commander of said oyster police boat that any person or persons have violated the provisions of this act or of the act of January session eighteen hundred and seventy-two, chapter one hundred and ninety-eight, as amended by this act, he shall arrest said offender and carry him before some justice of the peace within said county, and upon conviction he shall be subjected to the several fines and penalties as provided in section three of said act passed January session eighteen hundred and seventy-two, chapter one hundred and ninety-eight.

Unlawful to construct fish-trap, &c.

SEC. 4. *Be it enacted*, That it shall be unlawful for any person or persons to construct a fish trap, or pound net, or any fishing apparatus of like description, near the mouths of any of the tributaries of the said Potomac and Wicomico rivers within Charles county, between Maryland Point in said county and Chisildine's Island in St. Mary's county, for the purpose of fishing the same or for any other purpose, nothing herein contained to be construed to prohibit the fishing with said fish trap or pound nets by *bona fide* citizens of Charles county from the shores bordering on said rivers and tributaries within said waters, not being near the mouths of said inlets,

whereby the fish would be obstructed in their free passage to the head waters of said rivers and tributaries within said county. Any person violating the provisions of this section shall be subjected to the fines and penalties as provided in section three of the acts of eighteen hundred and seventy-two, chapter one hundred and ninety-eight.

Size of terrapins to be taken.

SEC. 5. *Be it enacted*, That no terrapins of a less size than six inches in length upon the bottom shell shall be taken from any of the waters within Charles county, under a penalty of five dollars for each and every terrapin of a less size than six inches in length upon said bottom shell so taken, said fine to be collected as provided in section three of the acts of eighteen hundred and seventy-two, chapter one hundred and ninety-eight; and it shall be unlawful for any person to take or catch any terrapin from the waters within said county, between the first day of April and the first day of November in each year; and any person violating this provision of this section shall be subjected to the same penalty as is provided for taking terrapins under the size of six inches upon the bottom shell, to be collected as is provided for the collection of the other fines and penalties imposed by this act.

DORCHESTER COUNTY.

Laws of 1878, *Chapter* 6, *Section* 1.

Patent Twine Weires unlawful to use.

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That it shall be unlawful for any person or persons to use the Patent Twine Weires or Weir Net Seines, for catching or taking of fish in the waters of the Black Water River, in Dorchester county.

FREDERICK COUNTY.

See Carroll County.

GARRETT COUNTY.

Laws of 1878, *Chapter* 108, *Sections* 38 *and* 39.

No person shall catch.

SECTION 38. No person shall take, catch or kill any speckled brook or river trout, or have any such trout in his or her possession, except during the months of April, May, June and July, under penalty of five

dollars for each trout so caught, taken, killed or had in his possession, but this act shall not prevent any person or corporation from catching trout in any manner or at any time in waters owned by them or upon their premises to stock other waters.

Shall not prevent.

Fines shall be collected.

SEC. 39. Said fines shall be collected as provided by section seven of this article.

HARFORD COUNTY.

Laws of 1878, *Chapter* 145, *Sections* 1 *and* 2.

Shall not take shad or any fish.

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That no person shall take shad or any fish in the waters of the Chesapeake Bay, or its tributaries, bounding on or lying within Harford county, by means of pound or stake nets, or any nets whatsoever that shall be attached to the bottom of said waters, or tributaries, by stakes, anchors, or any weights whatever. Nothing herein contained shall prevent any owner of land bordering upon said waters from catching fish for the use of their families and employees and actually consumed by them, provided such owners shall not place nets in any channel of said waters, nor more than one-fourth of the distance across any stream, and provided further, that nothing in this act shall prevent the use of fyke nets in the Susquehanna river.

Prevent any owner.

SEC. 2. *Be it enacted*, That any person violating the provisions of this section shall forfeit the nets hereinbefore described, and the boats and materials used for fishing the same, and shall also for each offence pay a fine of not less than twenty dollars nor more than fifty dollars.

Penalty.

PRINCE GEORGE'S COUNTY.

Laws of 1878, *Chapter* 452, *Sections* 1, 2 *and* 3.

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That it shall be unlawful for any person to catch, trap or kill any of the fish known as trout, bass or salmon, in the waters of the eastern branch of the Potomac and its tributaries in Prince George's county, within two years from the passage of this act, and after that time they are only to be taken with the hook and line between the fifteenth

Unlawful to catch or kill trout, &c.

day of August and the fifteenth day of May in each and every year.

Penalty for violation.

SEC. 2. *And be it further enacted*, That any person violating any of the provisions of the preceding section shall, upon conviction before a justice of the peace of said county, be fined not less than three dollars nor more than ten dollars for each offence, and upon failure to pay said fine and the cost of prosecution shall be sentenced to be confined in the county jail for a period not less than five days nor more than fifteen days.

Fines—how disposed of.

SEC. 3. *And be it further enacted*, That one-half of all fines imposed under this act shall be paid to the informer, and the other half to the County Commissioners for the use of the public roads.

ST. MARY'S COUNTY.

Laws of 1878, *Chapter* 502, *Sections* 1, 2, 3, 4 *and* 5. *See Charles County.*

SOMERSET COUNTY.

Laws of 1878, *Chapter* 280, *Sections* 1, 2, 3 *and* 4.

Unlawful to use patent twine, &c.

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That it shall be unlawful for any person or persons to use any patent twine, weirs, pound nets or hedges for the taking of fish in the waters of Somerset county.

Penalty for violation.

SEC. 2. *Be it enacted*, That any person or persons who may violate the provisions of this act shall, upon conviction thereof before any justice of the peace for said county, be fined for each and every offence the sum of twenty-five dollars, and the condemnation and forfeiture of the nets, twine, weirs, and boats or canoes used in violation, as provided in section one of this act.

Forfeit nets, &c.

SEC. 3. *Be it enacted*, That any person or persons who may be charged with violating the provisions of this act, upon conviction thereof upon trial before any justice of the peace in said county, in addition to the fine imposed by the preceding section, shall forfeit the nets, weirs, boats or canoes used in taking or catching fish as aforesaid, and upon said conviction the said justice of the peace shall order and direct the constable or other officer making the

Constable to sell.

arrest to sell the said nets, weirs, boats or canoes, after giving at least ten days' notice by advertisement inserted in some newspaper published in said county, or by advertisement stuck at three most public places, of the time and place of sale; and the said sale shall be for cash; and after deducting all costs and charges of advertising and making said sale, the balance of the proceeds of said sale shall be equally divided, and one-half thereof shall be paid to the informer, and the other half shall be paid over to the treasurer of the school board for the use of the public schools of said county.

Proceeds of sale—how disposed of.

Right of appeal.

SEC. 4. *Be it enacted*, That any person or persons feeling aggrieved by any decision under the provisions of this act, shall have the right to appeal to the Circuit Court for said county.

WORCESTER COUNTY.

Laws of 1878, *Chapter* 64, *Section* 6 *and Sub-Section* 6.

Not lawful

Seine.

SECTION 6. It shall not be lawful for any person or persons to haul or fish in any of the waters of Synepuxent Bay or its tributaries, comprised within the limits of "Worcester county," with any seine containing meshes less than one and a half inches square, unless said seine shall be less than one hundred fathoms in length.

Penalty.

SUB-SEC. 6. Any person who shall violate any of the provisions of the preceding section shall be deemed guilty of a misdemeanor, and upon conviction thereof before a justice of the peace, or upon indictment and conviction in the Circuit Court for Worcester county, shall be fined not less than twenty-five dollars nor more than one hundred dollars, one-half of said fine to be paid to the informer and the residue to the school fund of the county.

REPORT

OF THE

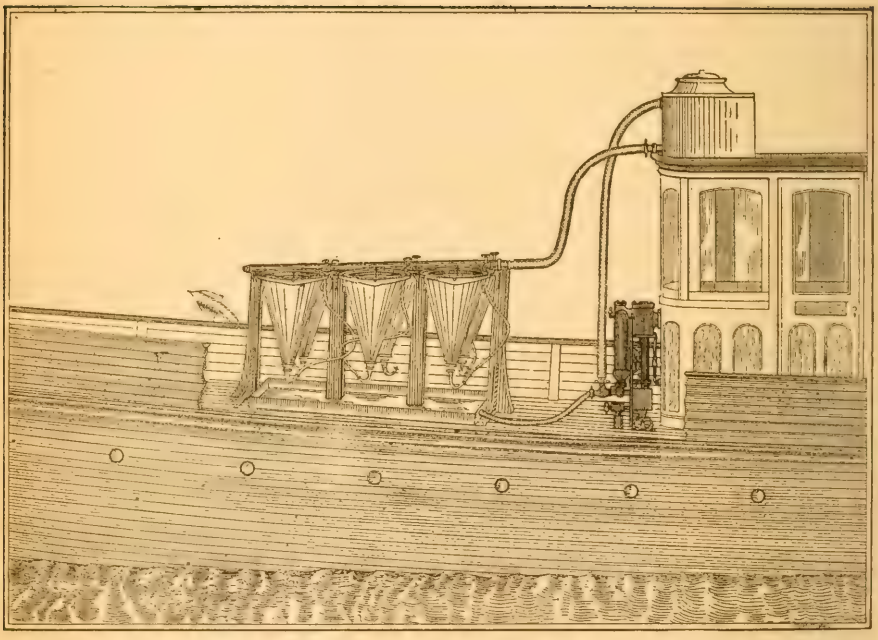
COMMISSIONERS OF FISHERIES

OF

MARYLAND

JANUARY, 1880.

ANNAPOLIS:
W. T. IGLEHART & CO., STATE PRINTERS.
1880.



Shad Hatching Equipment on Bow of Steamer Lookout.

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REPORT.

To his Excellency, JOHN LEE CARROLL,
Governor of Maryland:

In each successive Report of the labors of the Commission on Fisheries, in addition to a detailed statement of the actual work performed, we have given a minute description of the apparatus used in artificially increasing the supply of food fishes, and have traced, step by step, the advance that has been made in perfecting it.

We have also stated the results of investigations as to the development of the different varieties of food-fishes, and the varying degrees of success attending our efforts to propagate artificially those species which had not hitherto been the subjects of such experiment.

Although we cannot now report any appreciable improvement during the past year in the apparatus used, we are able to state that most satisfactory results have been realized from the employment of the methods already described. Heretofore the results obtained in other localities have formed the only basis on which we could promise an increase in the supply of our native food-fishes; but we are now enabled, from convincing statistics, to show the absolute increase in our own waters of shad—the fish which has been the object of our special care.

The sudden and marked increase in the supply of this valuable fish in the Chesapeake Bay is a result most flattering to the labors of the Commission. In the Report made to your Excellency in January, 1878, on page 6, we chronicled the noticeable increase in the supply of shad as reported by the fishermen in the neighborhood of Annapolis. As stated at that time, the return of adult shad could be expected during their third year, and the increase just mentioned was doubtless the result of our hatching operations in the spring of 1875.

In the year 1876 we transferred the base of our operations to the "Head of the Bay," and during that season nearly two million (2,000,000) of young shad were deposited in the Susquehanna and the Chesapeake Bay, near its mouth. The return of many of the males of these fish was to be expected in the spring of 1878, and of a much larger number, accompanied by adult females, during the following season.

As we have already stated in several previous Reports, the return of shad from the salt water to their native rivers is for the sole purpose of reproduction, and therefore only the adult shad make these annual migrations from the sea. Hence we could not expect, during 1877, any increase from the two millions (2,000,000) of young shad deposited, as above mentioned, in the Susquehanna River and Chesapeake Bay in 1876.

Through the kindness of a firm which has shipped the largest portion of the catch of the gill-nets in the neighborhood of Havre de Grace for several years, we have obtained the following figures. (Although the books of this firm do not show the actual catch of shad at the Head of the Bay, they indicate approximately the relative amount taken each year.)

For year	1870	48,527
"	1871	30,101
"	1872	62,451
"	1873	40,295
"	1874	50,246
"	1875	40,150
"	1876	35,539
"	1877	47,150
"	1878	50,310
"	1879	75,525

We have the record of the shipment of 45,000 shad in addition to the above in the season of 1879 by another merchant.

The decided increase in the catch of shad by the gill-nets may not be entirely the result of the deposit of the large number of young shad by the Commission, yet it is, doubtless, due in a great degree to that measure. It may be objected that the increase in the supply of shad in 1878 was caused by the state of the weather or water, or by the prevalence of

the wind in a certain direction; but, upon any one of these hypotheses, the same favorable conditions would cause a corresponding increase in the number of the other fish (the herring, for example), that usually accompany the shad in their annual migrations. So far, however, from this being the case, the herring fisheries last year were unremunerative, there being a great scarcity of that species. It will be remembered that the Commission has as yet taken no steps towards the artificial propagation of herring in Maryland waters, although we have carefully investigated their habits with a view to future operations.

In order to ascertain whether there had been the same marked increase in the catch of the haul-seines which are operated on the Susquehanna and Head of the Bay we have, through the courtesy of the owners of the large fisheries, examined their books, and have been able to ascertain, with tolerable accuracy, the amount of shad taken since 1872 by this mode of fishing. The books showing the catch of nineteen seines in this portion of the State give an aggregate yield of shad

In 1872	156,212
" 1873	133,050
" 1874	162,421
" 1875	252,829
" 1876	136,633
" 1877	152,765
" 1878	134,861
" 1879	188,870

The decrease of shad up to 1877 is, perhaps, much more marked than is shown in this table, as from several of the fisheries we could not obtain accurate records further back than that year, whereas the figures for 1877, '78 and '79 show the entire catch of the nineteen seines during those years. It will be noticed that in 1879 54,009 more shad were taken than during the previous season, and 36,005 more than the total catch of 1877.

As during the season of 1879 we could expect the return of the shad to the Potomac, Patuxent and other rivers where our operations were also conducted on a considerable scale,

we would look for a proportionate increase in the number of fish brought to and consumed in the city of Washington. Unfortunately for us, Washington is the only place where an accurate record of the fish product is kept. The Health Commissioner of that city is required to inspect all marine products and report the number examined. We have taken from his reports the numbers inspected during the same period, and there the increase is as noticeable as at the Head of the Bay.

In	1872	he inspected.....	917,221 shad.
"	1873	"	852,900 "
"	1874	"	628,637 "
"	1875	"	464,215 "
"	1876	"	319,079 "
"	1877	"	131,199 "
"	1878	"	121,785 "
"	1879	"	328,435 "

We have additional testimony tending to prove that the increase of the supply of shad is the result of artificial propagation. By reference to our report of January, 1877, which recorded the shad hatching operations at the Head of the Bay, it will be noticed that a large number of fish were deposited in Swan Creek. During that season we were compelled to seek a locality in which there was a current sufficiently strong to afford to the eggs the necessary agitation and change of water. We, therefore, established one of the hatching stations on the creek just mentioned, as it offered the required conditions, and to that point transferred nightly the eggs taken on the flats. As soon as the fish were hatched they were deposited in the immediate vicinity of the hatching station. During last season, after an almost total absence of many years, adult shad appeared in this creek in such numbers as to attract several fishermen, whose labors were here amply rewarded.

The fishermen who operated there last season report a preponderance of small male or *buck shad.*

We have not, hitherto, felt justified in promising to do more by artificial propagation than simply to arrest the alarming decrease in the yield of the fisheries of the State. But from the results already obtained we are now confident of our

ability to render our waters as productive of the most useful varieties of food-fishes as they have ever been.

That we are daily becoming better fitted to realize this expectation is evidenced by the marked increase in the number of fish produced at the headquarters of shad hatching operations in Maryland.

A reference to the tables giving the result of our efforts will show that we deposited in these waters during the spring of 1876, 2,724,000 young shad. Next season this number was increased to 2,134,800; in 1878 to 8,285,000; and in 1879 to 7,757,000.

Since the inauguration by us of the new system of hatching shad—which is independent of the necessity for a strong current, to obtain which we were often compelled to visit remote parts of the State—the yield has been steadily increasing, and now the means of hatching are such that the quantity produced is limited only by the number of trained experts available for collecting the eggs. In 1874, when the Fish Commission was organized in Maryland, there was not a single person in the State who had ever taken or artificially hatched shad eggs, but there are to-day many men trained by the Commission in the manipulation of shad and other fishes who are as expert as any in the country.

An account has already been given of the results of experiments by the Commission in the artificial propagation of smelt and herring, and we are now enabled to record our success in propagating, by similar means, another species, more important, perhaps, than any of the fishes that have hitherto been the object of the care of fish culturists. We refer to the rock-fish (*roccus lineatus*).

Our previous reports have called attention to the importance of this species, which we consider second to none of those frequenting our waters. We have also reported our constant but futile search for its spawning grounds, and for a ripe female of this fish. We are now, however, happy to record our success, not only in the search for the ripe fish, but in the discovery of the spawning grounds; and we have been reasonably successful in the manipulation of the eggs.

There is no fish in our waters whose decrease has been more marked than that of the Rock, and none which occupies a more important place among the food-fishes. Though never seen in our markets in such numbers as the shad and herring, they are in season nearly the whole year, and to be procured almost daily in greater or less abundance in our principal fish depots. Thriving as well in the fresh waters of our rivers as in the salt water of the sea, or the brackish water of bays and inlets, they are found in almost all the tidal streams of the State. To a large number of people, therefore, an abundant supply of them is to a greater extent, perhaps, than of any other fish, an important desideratum.

On the organization of the Commission our first work was to investigate the waters of the State with a view to ascertain their capacities as well as their needs. In prosecuting these researches we were enabled to make a very large collection of specimens of the ichthyology of the State, and to discover the existence in our waters of many species that have never before been seen in them, and of others that were new even to the Atlantic coast.

In our report of January, 1876, we published a descriptive list of the fishes of the State, to which list additions were made in two subsequent reports. We discovered, last year, the presence of a number of fish not included in any of the lists referred to, as they were not before known to visit our waters.

After the investigations above mentioned, our labors were addressed to the task of supplying the deficiencies that were found to exist.

In order to obtain information on certain important points, Col. Hughlett, one of the Commissioners for the State of Maryland, addressed circulars containing the necessary questions to a large number of persons likely to be interested in the fisheries on the Eastern Shore. The answers, in full, to these questions received up to January 1st, 1880, are herewith transmitted, though we do not endorse the views contained in many of them.

Most of the information sought in these interrogatories will

be furnished by the Census Bureau in preparing statistics, &c., for 1880. If, however, the items obtained from this source are not satisfactory and complete for the State of Maryland, we will issue during the ensuing season another series of questions calculated, we trust, to elicit all necessary information.

The following are the questions, as above stated, by Col. Hughlett:

QUESTIONS.

1. Have you ever engaged in fishing for a livelihood, and if so, for how many years?

2. In what waters do you usually fish?

3. Have you ever studied the habits of fish?

4. When do shad spawn in your waters, and are they more abundant before or after the spawning period?

5. Do you keep an account of the number of fish you catch during the season, of the temperature of the water and of the range of the winds?

6. How does the shad-fishing of this season compare with that of last year, and of the past few years? Please state what you consider the cause of the increase or the decrease, as the case may be.

7. What kinds of fish do you catch in your river, and in what proportions? What fish do you consider best adapted to your waters?

8. Have you kept an account of the number or quantity of fish you have sold for several years past? If so, please state the proportions of rock, of shad, of herring, of taylors, of perch, and of any other fish, and the ruling price of each kind on the shore.

9. Have you ever caught a ripe female rock?

10. Which sex of the rock predominates, and in what ratio?

11. What are the size and weight of the largest you ever caught, and can you tell the average growth per year?

12. Do the sexes differ in respect to shape, size and rate of growth?

13. Do you consider the rock too destructive to other varieties of fish to justify its artificial propagation.

N. E. Nicols, *Easton, Maryland.*

1. Have fished at different periods for forty years. Have never fished for a livelihood.

2. In the Great Choptank River.

3. Have not. Have learned more from practical experience than in any other way.

4. Spawning commences in April, but greater part is done in May and early part of June. Shad are most abundant from middle of April to first of May in our waters.

5. Have kept account sometimes. Have not specially observed the temperature of the water, or the range of the winds.

6. I think there has been a gradual decrease for several years, caused by the wholesale and destructive manner of fishing in the lower Choptank by the use of set and fyke nets, catching up the female shad before they reach their spawning grounds.

7. Catch more shad, herring, rock and perch than any other kinds. Catch mostly shad and herring in the river named. Rock and perch are caught more or less throughout the season. I think the several species here named best adapted to the Choptank.

8. Have not kept account of number caught. Shad generally bring from *ten* to *fifteen* or *twenty* dollars per hundred, herring from seventy-five cents to one dollar on shore, and large rock say five cents per pound.

9. Have caught ripe female rock in latter part of April and first of May.

10. The *male* always predominates.

11. The largest about seventy or eighty pounds. Know nothing of their growth per year; wish I did.

12. The female rock is generally larger than the male, but they do not differ much in shape. Know nothing about the rate of growth.

13. I think not.

A. D. Sessions & Co., *Baltimore, Maryland.*

1. Have fished for twenty-two years and have been connected with the fishing business for forty-eight years.

2. Chesapeake Bay, Patapsco River, Sassafras River, Susquehanna River, Bush, Gunpowder, Back, Chester, Magothy, Wye, Severn, South and West Choptank and Patuxent Rivers and numerous creeks.

3. I have, but only in their season.

4. In the month of May, and they are more abundant before spawning than after.

5. I have never kept such account.

6. No conclusion can be arrived at yet, as it is too soon, in my opinion, to estimate the quantity.

7. The permanent fish in our waters are mud-shad, rock, perch (white and yellow), pike, sun-fish, sturgeon, mullets, chub, eels and cat-fish.

The transient fish are shad, herring, alewives, taylors, sheepshead, porgies, trout, spots, flounders and Spanish mackerel. The permanent fish are best adapted to our waters. Shad, herring, alewives, taylors and mackerel are caught in abundance during their season, but the other transient fish specified are taken in limited numbers. The supply of fish is being constantly exhausted.

8. I have not kept such account.

9. The female is generally the larger. Have never caught a ripe female rock.

10. Male predominates. Don't know, as I have never noticed.

11. Have caught rock weighing eighty-six pounds. I think a rock more than doubles its size every year.

12. They are about the same.

13. No.

G. W. Jones, *Baltimore City.*

1. Yes, for forty years.

2. In Chesapeake Bay.

3. I have studied the habits of fish.

4. From 24th to 28th of April and up to 10th of June.

5. Yes, the temperature of the water rises and falls, and the winds blow heavy and light.

6. There is an increase in the shad this year. The people

who haul the channel catch and boil them for the purpose of making oil.

7. Rock, white and yellow perch, shad, herring, pike, mullet, sun-fish, cat-fish, bream, shad, sturgeon, crocus, diamond-fish, sheepshead, taylors, horse-mackerel and black-fish. Occasionally we catch a salmon-trout, silver gar and drum. Rock and perch are the best adapted to our waters.

8. About fifteen hundred bunches of rock, averaging ten pounds per bunch, and about 1,190 bunches of perch and other fish. About twenty six years ago I caught 4,586 bunches of rock at one haul.

9. Yes.

10. Yes.

11. I have caught rock of ninety pounds weight. A rock will grow about three or four inches in length per year, and will increase in weight about one pound.

12. The female rock is the larger.

13. No.

J. P. Todd.

1. I have for thirty-five years.

2. Choptank river.

3. I think I have.

4. From the 10th to the 20th of May.

5. I think the boats average from 500 to 600.

6. I don't think there will be as many shad this season. I think the pound weirs are breaking up the fish in these waters. They catch the young fish as soon as they are born.

7. Shad, herring, rock, perch and cat-fish.

8. From 500 to 1,000 per annum. Shad, ten cents to twenty cents each; rock, three cents to five cents each; perch, from eighty cents to one dollar per hundred; herring, from seventy-five cents to one dollar per hundred.

9. I have caught ripe female rock.

10. I think the male rock is ripe any time in spring. A ripe female rock is not often caught.

11. I have caught rock weighing from one to sixty-five pounds.

12. I don't think I do.
13. No.

R. S. Emory.

1. About twenty years.
2. In Chester River.
3. I have not.
4. In the month of May. They are most abundant about April 20th.
5. I do not.
6. Much less. Cannot state cause. Have known them to be as scarce in previous years and then rapidly increase.
7. I. Rock, perch, white and yellow; cat-fish, mud-shad, shad, herring, crocus, taylors and mackerel. II. White and yellow perch principally. III. White and yellow perch, rock, shad and herring.
8. I have not.
9. I have not.
10. I. The male largely predominates. II. It is.
11. I. From sixty to seventy pounds. II. I do not.
12. They differ in shape, the male being the longer.
13. It is not.

Solomon Brinsfield.

1. I have never followed fishing for a livelihood, but sometimes angle for family use or for sport.
2. In the waters of Broad Creek.
3. Have not. The taylors visit our waters for about six weeks every year during August and part of September. Rock are easily frightened and driven away by the haul-seine.
4. We have no shad. They do not spawn in our waters.
5. Do not keep any account. In fact, may say I catch none, as there are none to catch, thanks to the haul-seines and other traps and modes of destruction. The haul-seine is by far the greatest enemy with which the fish have to contend, and should be abandoned absolutely.
6. Know nothing about shad-fishing, as there are none of

that species in our waters. If there is a decrease (and such, I am informed, is the fact) it is due to the haul-seine.

7. We catch (or rather, did catch some years since) rock, perch, crocus and taylors in their season, and sometimes trout and a few other varieties. We catch now a few taylors, the haul-seine not having destroyed all of that species, as they are migratory and not permanent in Maryland waters. I consider the rock, when protected, the best adapted to our waters, as it is native to them, and decidedly the best and most profitable food-fish.

8. Do not sell fish, and am ignorant of the price of them, but know that the price rules higher each year as the fish become scarcer.

9. Have made no observations worthy of note, and would not know a ripe female.

10. If I judge rightly the *male* greatly predominates. Would not know a ripe one of either sex.

11. On these points am ignorant. During a part of last fall a large number of small rock, about a foot long, were in our waters. Some of them probably escaped the haul-seine, as I have seen a few caught this fall, and the average length was fifteen or sixteen inches, from which fact I judge they grow in length about three or four inches a year.

12. As before remarked, the female of the same length is much broader, stouter and heavier than the male. Do not know about rate of growth.

13. Not by any means. Think there is no doubt that the rock should be propagated in every possible way. They are certainly, in my opinion, the most valuable food-fish in our waters; but it is not only useless—it is simply *absurd*—to try to propagate them without protection. If the haul-seine is not speedily abolished the rock will, in a very short time, become extinct in our waters. There is no escape if the haul-seine is allowed to sweep our coves, creeks, rivers, &c., indiscriminately. They feed to some extent on young fish, such as minnows, young alewives, &c., but I do not think them as destructive to young fish as the taylors are.

J. H. S. Hubbard.

1. Have been engaged in fishing and dealing in fish for about twenty-five years.

2. In the Great Choptank River.

3. Have closely observed the habits of fish for many years.

4. Shad begin to spawn about the 25th of April and continue until the 1st of June. They are rapidly diminishing.

5. I keep an account of the catch, the temperature of the water and the range of the winds. The temperature of the water is from 30° to 50°. The best catch is made when the water is from 35° to 45° and the wind south, southwest, west and northwest. Fishing is poor in these waters when wind is from east or northeast.

6. Shad are diminishing at the rate of one-tenth per year. We attribute the decrease to the very effectual blockade of the lower part of the Choptank River by weir or stake nets, which destroy many fish and turn many back that would come up but for these obstructions.

7. We catch shad, herring, rock, perch, pike and cat-fish, of which three tenths are shad, one-tenth herring, and six-tenths rock, &c. The white cat-fish is a valuable fish and ought to be propagated, as like all other fish in our waters it is rapidly diminishing.

8. Have kept an account of the fish sold since 1873. The catch has diminished one-tenth per year up to the spring of 1879. The herring are almost exterminated. Of the number caught three-tenths were shad, one-tenth herring and six-tenth were rock, perch, pike, cat-fish and other fish. I would call your attention to the importance of the earliest possible preparation for the propagation of herring. Twenty years ago the Eastern Shore rivers furnished enough of this fish to supply all that section of country, as well as Delaware, with salt food-fish, whereas in the spring of 1879 many people living along the Choptank could not get a fresh mess. The people of the Eastern Shore depend much on a supply of small bone bacon.

9. I have closely observed rock-fish. Have obtained ripe female rock on but five occasions.

10. Have never seen a ripe female rock weighing less than fifteen or twenty pounds, and but five under twenty pounds. They were all small rock. The roe has the appearance of smelt. We catch at least nine male rock where we catch one female.

11. The largest rock I have ever caught was five feet one inch long and weighed 92½ pounds, and was in a spawning condition when caught. The increase in weight for the first year is from 2½ to 3 pounds, the second year, 4 to 6 pounds, third year, 8 to 12 pounds, fourth year, 12 to 20 pounds, at which age they mature for propagation.

12. All small rock have the same appearance until they attain the weight of 16 or 20 pounds; then nine-tenths of the catch of rock are females. How do you account for that?

13. I don't think the rock-fish is destructive. They are river scavengers, and in cold weather move in immense schools, taking up useless little pests, such as minnows, mill-roach, sun-fish and other small fry that destroy the food of more delicate fish. In summer they scatter all over the river and feed on the accumulated pests. At the approach of frost they form schools and move to and fro in the water.

N. B. I would call your attention to the protection of the alewife. I think the law should prohibit the catching of them at all times when it could be avoided. They are fish that prey on the fish-leach, flea and fish-lice that inhabit the waters in large numbers, much to the annoyance of the fish. Their young are eaten by rock in large numbers.

Littleton Smith, *of Wicomico County.*

1. I have for twenty-five years.

2. In the Wicomico River.

3. I have.

4. They are more abundant about the last of April and the first of May than at any other time.

5. I have not kept an account of the number of fish caught or temperature of the water.

6. The catch of shad was larger this year than for several

years previous. I attribute the increase to the efforts of the Fish Commission.

7. Shad, herring, rock, perch, pike, mullet, sun-fish, roach and cat-fish. Shad, herring, rock and perch are the principal fish caught in our river, and I think that they, with the black-bass, are best adapted to our waters.

8. I have kept no account of the number of fish sold for several years, but think about one-eighth rock, three-eighths shad and the balance herring and perch.

9. I have—I have.

10. The male or stag rock is the more abundant. Very seldom caught a ripe female.

11. Seventy-five pounds. I know nothing of their growth.

12. They do.

13. I think not.

ANDREW AIREY, *Dorchester County.*

1. I have for forty years.

2. Choptank River.

3. I have.

4. From 20th of April to same time in May.

5. I do not.

6. Shad have been fewer for several years. I attribute decrease to stake ponds. There have been more rock for the past two years than for the fifteen years previous. I attribute increase to the Fish Commission.

7. Rock, perch, shad, herring and taylors mostly. Rock are best adapted to our waters.

8. Mostly rock and perch. The prices vary according to the markets.

9. I have frequently seen ripe rock.

10. There are a great many more male rock.

11. Seventy-five pounds. Cannot tell growth, but they grow very fast.

12. The female is short and thick; the male is long and slender.

13. The rock is not destructive, and I deem it by all odds

the best fish to propagate here, because it is the strongest and hardiest species of fish in our waters.

EDGAR DASHIELL.

1. For twenty years.
2. Wicomico River.
3. No.
4. Shad spawn from May 15th to June 15th.
5. The catch of shad is now seventy-five per cent. less than it was twenty years ago.
6. I attribute the decrease to hauling seines during spawning season and to the spawn being eaten up by eels.
7. Shad, herring, rock, perch and taylors. Other fish might prosper if tried in our waters.
8. No.
9. No.
10. Yes. (Mr. Dashiell, the gentleman who filled this up, says that he has frequently caught female rock with roe, but not ripe.)
11. The largest was over eighty pounds.
13. I don't think rock are very destructive to other fish.

JOHN WILSON, *Landing Neck, Talbot County.*

1. I have fished for twenty-five years, more or less.
2. Have fished in Miles River occasionally, but for the last fifteen years principally in the Choptank.
3. I have to some extent.
4. They usually spawn about the last of April or the first of May. Some not before the fifteenth of May. They are most abundant about the last of April.
5. Have caught as many as 2,000 shad in one season, but for the last three years they have been scarce. Have kept no record of the temperature of the water, nor of the range of the wind, but have noticed that no fish are caught when the wind blows from the east.
6. Last season was a very poor one—worse than for many years past. Nothing like as good as some years back. I at-

tribute the falling off to the setting of pound nets in the lower Choptank and to fishing after the ripe shad begin to spawn.

7. I catch mostly shad. Perch and cat-fish are also caught.

8. Have kept no account of number and kinds caught. Used to keep an account of what each boat caught five years ago. They averaged then 2,000 to a boat. Last season the average was not above 500 each. Last season shad were twenty-five cents a piece, three years ago they were ten cents.

9. Have never caught a ripe female rock and have had no opportunity of observing the habits of rock-fish.

10. Have had no experience with ripe rock, male or female.

11. Sixty pounds. I know nothing of their growth.

12. The female is short and thick, the male is long and slender, but fully as large as the female.

13. I do not consider the rock a very destructive fish. It is one of the most profitable fish in our waters, as it can be caught in all seasons. It would be well to have our waters filled with them.

ANDREW TOWERS.

1. Ten years.
2. Choptank River.
3. Yes.
4. From 1st to 10th of May.
5. Sixteen hundred shad in thirty days; winds box the compass.
6. A decrease. Cause—lake fishing in time of spawning.
7. Shad.
8. Shad average 15 cents, herring average 75 cents, rock, 5 cents per pound.
9. Yes.
10. The male predominates.
11. Seventy pounds.
12. Yes.
13. No.

William Fletcher, *Wicomico County.*

1. I have for thirty years.
2. In the Wicomico River.
3. I have.
4. They are more abundant about the last of April and the first of May than at any other time.
5. I do not.
6. The catch of shad was larger this year than for several years previous. I attribute the increase to the operations of the Fish Commission.
7. Shad, herring, rock, perch, pike, mullet, sun-perch, roach or butter-head, and cat-fish. Shad, herring, rock and perch are the principal fish caught in our river, and I think that they, with the black bass, are best adapted to our waters.
8. I have kept no account of fish sold, but think about one-eighth was rock, three-eighths shad, and the balance herring and small fish.
9. I have.
10. I have. It is a fact.
11. Forty pounds. I know nothing of their growth.
12. They differ in size. I know nothing of their growth.
13. I think not.

Levin Malone, *Wicomico County.*

1. I have for twenty years.
2. In the Wicomico River.
3. I have.
4. They are more abundant about the last of April and the first of May than at any other time.
5. I do not.
6. The catch of shad was larger this year than for several years previous. I attribute this increase to the work of the Fish Commission.
7. Shad, herring, rock, perch, pike, mullet, roach and cat-fish. Shad, herring, rock and perch are the principal fish caught in our river, and I think that they, with the black bass, are best adapted to our waters.

8. I have kept no account of fish sold, but think about one-eighth rock, three-eighths shad, and the balance herring and small fish.

9. I have.

10. I have. It is a fact.

11. Ninety-five pounds. I know nothing of their growth per year.

12. I have noticed that the male rock is slenderer than the female.

13. No. I think the rock can be successfully propagated in our waters. They feed on such fish as the roach or butter-head, and those of large size sometimes eat herring in spring. They come up our river twice a year, *i. e.*, in the *spring* and *fall.*

JAMES WILLIS, *Oxford, Talbot County, Md.*

1. Have fished for pleasure only, not for a livelihood, since 1829.

2. Tuckaho Creek, in Oxford, for the last twenty years.

3. No.

4. Usually spawn in March and up to June.

5. Cannot answer this question, as the wind has often been known to "box the compass" five or six times a day.

6. None, compared to what it was in 1831. Still decreasing, owing to the large number of haul, float and set seines and wier nets. Unless the necessary steps are taken to prevent further destruction we will have no shad in five years.

7. Rock, sturgeon, taylors, perch, sheeps-head, crocus, doutys-plenty, eels, thorny-backs, horse-mackerel, trout and pike.

8. No.

9. No.

10. No.

11. Twenty pounds.

12. Male rock is thin-gutted; female rock is large-gutted.

13. No.

JOHN MEREDITH, *Cambridge, Dorchester County, Md.*

1. I have for nearly thirty years.
2. Choptank and Transquakin Rivers.
3. A good deal.
4. They spawn in latter part of April and in May.
5. I do not.
6. It has been better than last year or for several years past, but do not know to what to attribute it.
7. Shad, herring, rock and perch mostly. Also trout, taylors, pike and crocus. The first four are best adapted to our waters.
8. I have no account.
9. I do not know that I have.
10. I can hardly tell.
11. Three and a half to four feet. Don't know weight.
12. Female is thick; male slender.
13. I do not think so.

TILGHMAN H. THOMAS.

1. For fourteen years.
2. Choptank River.
3. I have.
4. From the 2d of May to the 20th. In greater numbers before they are ripe.
5. No. From three to fifteen hundred. Temperature of water not known. Winds "box the compass."
6. Decrease; caused by the river being blockaded, keeping the fish from schooling, and also by catching them in spawning time.
7. Shad, herring, rock and cat-fish.
8. No. From three to fifteen hundred. Price for shad, ten cents to twenty-five cents; herring, seventy-five cents per hundred; rock, four cents per pound.
9. I don't know that I ever caught a ripe female rock.
10. I have caught numbers of ripe male rock.
11. Sixty-two pounds. I don't know how fast they grow

12. Sexes differ in respect to shape and size. Rate of growth not known.

13. Hav'nt given the question any consideration.

JOHN W. BROWN.

1. Twenty years.

2. Nanticoke River.

3. Yes.

4. Spawn about middle of May. More abundant before spawning season, say in April.

5. Catch from five to six thousand herring.

6. Better than for six or seven years. A hard winter is generally followed by a good fish season, as the fish that are kept back by the cold weather come in large numbers at the opening of the season.

7. Herring, perch, shad and rock. Same quantity of perch, herring and shad—not more than two hundred rock. I consider cat-fish and perch best suited to our waters.

9. I have seen rock spawn.

10. Males predominate in ratio of five to one.

11. Have caught a rock weighing fifty-five pounds. Cannot tell average growth per year.

ROCK FISH—*Roccus lineatus.*

Our long search for a ripe rock was rewarded by the capture, by Dr. Capeheart, at the Scotch Hall Fishery, on the 6th of May, of three large females of this species with ripe spawn. They were landed about four o'clock in the afternoon, and immediately reported to William Hamlin, one of the experts of the Shad-hatching Corps. He stripped them, and the eggs taken filled two large pails of about six gallons each. This Fishery was about three miles distant from the hatching station, and he was not provided with the proper means of preserving the eggs. During their impregnation the pans used in shad-spawning were filled, and it was necessary to transport the eggs from the Fishing-shore to the central station in an almost solid mass. Mr. Hamlin reports

the eggs, when first spawned, to be of a pale-green color, slightly larger than those of herring; but becoming, after impregnation, somewhat larger than shad eggs, and losing their color and opaqueness, being transparent and almost invisible, an oily globule alone arresting the attention.

They were placed in the hatching vessels; some in the cylinders used for shad-hatching, some in the cones and others in floating boxes. While the eggs were being rinsed and manipulated, many hundreds of thousands of them were poured overboard at the wharf to which the steamer was moored. Quite a large number of them, however, apparently in good condition, were placed in the hatching vessels about midnight on the sixth. The following table shows the temperature of the air and water during the period covered by the hatching of these eggs:

DATE.	Temperature of				Temperature of				Temperature of			
	Air.	Surface Water.	Bottom Water.	Water in Cones.	Air.	Surface Water.	Bottom Water.	Water in Cones.	Air.	Surface Water.	Bottom Water.	Water in Cones.
	6 A. M.				12 M.				6 P. M.			
May 6.....	68	65	65	65	82	71	69	69	69	71	70	70
May 7.....	68	67	67	66	61	67	67	66	60	68	67	67
May 8.....	56	63	64	62	67	66	65	64½	62	64½	64	64
May 9.....	56	64	62	62	67½	63	63	65	60	64	64	64

On the morning of the ninth almost all of the eggs were hatched, showing a much more rapid development than that of shad eggs under similar circumstances.

After being hatched, the fish were found to be considerably smaller than shad, but with much larger umbilical sacs. So small, in fact, were they, that it was impossible to confine them by the wire cloth used in the propagation of shad. Most of those hatched made their escape through the meshes of the wire cloth. Several thousands were dipped out from the hatching vessels and placed in transporting cans, and many of them were carried to Washington and some to Baltimore. The last mentioned were placed in the running water at the hatching house in Druid Hill Park. As a matter of experiment, several thousands of these young rock were placed in a tin pail on the deck of the steamer Lookout, and kept there without change of water. They were alive, and apparently healthy, ten days after being hatched. During a considerable part of the time they were on deck and exposed to the rays of the sun. This experiment shows that young rock can be much more easily transported than young shad; and that, in its earliest stages at least, it is a very hardy fish. This is an important consideration in view of the fact that, in order thoroughly to stock the waters of the State, the limited area of the spawning grounds of the rock may render it necessary to procure the eggs and hatch the fish at some point remote from the waters intended to be stocked.

The capture of these fish at so advanced a period in the season would seem to indicate that their spawning time is somewhat later than that of the shad. This may account for the failure, heretofore, to find ripe rock among those taken while fishing for shad and herring.

The fishing season in Albemarle Sound usually ends about the 1st of May, but during last spring the fisheries owned by Dr. Capeheart were continued to a somewhat later date. The table giving the details of shad-hatching operations on pages xxx to xxxiii show that the spawning season of shad in Albemarle Sound extends from the latter part of March to the first of May. We have not been able heretofore to find ripe shad

later than the period last mentioned, as the fisheries have closed on or before the 1st of May. Dr. Capeheart reports the young rock as appearing in large numbers in the month of August, in Salmon Creek, near the shad-hatching station. As the presence of large numbers of young rock has never been noticed in this locality before, it is probable that those referred to as appearing in the month of August were the product of the eggs obtained on the 6th of May, and artificially hatched; for, as already stated, many hundreds of thousands of eggs were thrown overboard while rinsing and manipulating them, and in addition, the vessels in which the rock were hatched were so constructed as to render their escape easy, as soon as they were freed from the eggs. It is matter of regret that the discovery of ripe rock—for which constant search had been made during six years—should have been so unexpected as to find us totally unprepared to make a thorough success of our experiments, or to observe the development of the eggs, with that care which their importance demands. We trust, however, that in the future we will have an opportunity of making a more careful study of this fish, and of hatching it on a scale sufficiently large to insure practical benefits therefrom.

Shad—*Alosa sapadissima.*

The success which attended the experiment of establishing a shad hatching station on Albemarle Sound during the previous year caused Prof. Baird to desire a continuance of the work during last spring in North Carolina. Although our efforts to transfer the fish hatched at that point to Maryland waters had not proved successful, yet we deemed it of great importance to co-operate with Prof. Baird in this work, especially as it was a portion of his programme to remove his entire equipment from Albemarle Sound, at the close of the season in that latitude, to the Head of the Bay, and continue in Maryland waters the work of shad hatching. We did not propose to attempt the removal of the fish from that point to our own streams. Our object in desiring to assist the United States

Commissioner in effecting a large southern distribution from the fish produced in North Carolina was to enable him to devote to the stocking of our own waters a larger proportion of the fish obtained in Maryland than we could otherwise have secured. We, therefore, very readily contributed the use of the steamer Lookout and the apparatus arranged on her deck (described in a previous report); and we also transferred the trained men who were in the employ of the Maryland Commission, the U. S. Commissioner defraying their expenses and paying their wages during the shad-hatching season.

As the equipment referred to was a modification of that hitherto used, we give a representation of it in the frontispiece of this report.

Notwithstanding the fact that the main object in our cooperation with the United States Commissioner was to enable him to devote a larger percentage of fish produced in Maryland waters to stocking our own streams than would otherwise have been possible, yet as the United States Commission was willing to turn over to us what fish we wished for Maryland waters, we secured two shipments of about 300,000 each, which we endeavored to transfer to the waters of the Eastern Shore by steamer from Norfolk. The steamer Lookout being fully engaged in producing the fish, we communicated with His Excellency, Governor Carroll, presiding over the Board of State Fishery Force, and obtained from him the detail of the steamer Lelia, which proceeded to Norfolk for the purpose of transferring these fish, arriving there on the 6th day of May. We had hoped to secure the services of the Lelia immediately after the close of the oyster season, but from some cause she was delayed until the above-mentioned date; and unfortunately, upon the very day of her arrival at Norfolk, a violent easterly storm set in and continued for nearly a week. The young fish placed in charge of Mr. Thomas Hughlett, Jr., on board the Lelia, and although no effort was spared by this young gentleman to keep them in good condition, they all died before the weather permitted the steamer to leave port. It affords us pleasure to give the testimony contained in letters received

from Captain Travers, commanding the steamer, and Colonel Hines, the former commander, who was on board, testifying to the faithful discharge of duty by Mr. Hughlett.

BALTIMORE, May 15, 1879.

T. B. FERGUSON, ESQ.

DEAR SIR: I was on the steamer Lelia last week when she was down the bay for the purpose of carrying your young shad to the Eastern Shore rivers.

The weather was exceedingly rough from the time we reached Norfolk until Monday last, and though Mr. Hughlett took every pains and care of the young fish sent him, they died before Sunday.

I looked into the cans when they were first received at Norfolk, and found some dead ones, but though he regularly every second hour, night and day, carefully drew from the cans about two gallons of water and supplied a like fresh amount from the steamer's tanks, attending to it himself, trusting to no one to do it, they, after the run from Norfolk to Fortress Monroe, when we had to harbor on account of the heavy sea, began to die very rapidly.

This trip of Mr. Hughlett was, he told me, the first he had taken with young fish, and I have written this letter that you might understand that the failure to get the fish to their destination was due in no way either to him or Captain Travers, who gave him every assistance in his power, but to the weather and causes beyond the control of man.

Respectfully yours, JESSE K. HINES.

T. B. FERGUSON. NORFOLK, VA.

DEAR SIR: Yours of the 7th, and also nine tins of young shad, came to hand in due time. I can only say, as soon as we could procure sufficient water for the fish we proceeded on our voyage to Crisfield. When we got as far as Fortress Monroe we found the wind and sea too much for such a ship as the Lelia, and went into Old Point and remained until the morning; and Mr. Hughlett, finding his fish over two-thirds dead, and no prospect of us being able to

cross the bay, he concluded to return to this place and await a fresh supply. Should the weather continue boisterous we will not be able to render you the assistance that I much desire to do. Yours truly, SAMUEL M. TRAVERS.

No other attempts were made to transfer the fish from the North Carolina Hatching Station to Maryland waters during the season, as we deemed it best for the interests of the State to postpone the acceptance of any aid which the United States Commission might be disposed to render us until the opening of our season, and the removal of operations to the "Head of the Bay."

Although our efforts during these two years to remove the fish from this station, where they are produced in such large numbers, resulted in comparative failure, we have gained most valuable experience, and have devised apparatus in which the fish can be readily transferred when it becomes necessary to repeat the attempt.

We deem it proper to call your attention to the following table (which the courtesy of the United States Commissioner enables us to produce) showing in detail the shad-hatching operations conducted on Albemarle Sound, as the services of the steamer Lookout and the apparatus contributed, as well as the detail of the men above-mentioned, have in a great measure identified the Maryland Commission with this important work:

RECORD OF SHAD HATCHING OPERATIONS *conducted in Salmon Creek, Albemarle Sound, on the Steamer Lookout, at Avoca Wharf, from April 11th, 1879, to May 14th, 1879, on account of United States and Maryland Commissions, by John S. Saunders.*

Date.	Temperature of									Wind.						Condition of	
	Air.	Surface water.	Bottom.	Air.	Surface water.	Bottom.	Air.	Surface water.	Bottom.	Direction.	Intensity.	Direction.	Intensity.	Direction.	Intensity.	Sky.	
	6 A. M.			12 M.			6 P. M.			6 A. M.		12 M.		6 P. M.		6 A. M.	12 M.
April 11.	....	....	....	50	54	54	....	....	....	N E.	Strong.	N.E.	Strong.	N.E.	Strong.	.....	Overcs't
" 12.	....	....	....	49	55	54	....	....	....	S.	Strong.	S.	Strong.	S.	Strong.	.....	Clear.
" 14.	56	57	57	68	59	59	62	59	59	S. to E.	Light.	S. to E.	Light.	S. to E.	Light.	Thun, Lig	g.& Rain
" 15.	59	57	57	73	59	60	71	61	61	S W.	Strong.	S.W.	Strong.	S.W.	Strong.	Clear.	Clear.
" 16.	60	60	59	68	62	60	63	60	60	S to N E	Variable	S.to N.E	Variable	S toN.E.	Variable	Cloudy&	Raining
" 17	64	60	60	62	59	59	65	60	60	S. to W.	Variable	S. to W.	Variable	S to W.	Variable	Raining	Raining.
" 18.	45	56	55	59½	58	58	52	58	57	N.W.	Strong.	N.W.	Strong.	N.W.	Strong.	Overcs't	Overcs't
" 19	47	56	56	59	58	58	55	58	58	N.W.	Heavy.	N.W.	Heavy.	N.W.	Heavy.	Clear.	Clear.
" 20.	45	56	55	64	60½	59	63	60	60	N.E.	Gentle.	N.E.	Gentle.	N.E.	Gentle.	Clear.	Clear.
" 21.	52	58	58	71	64	61	70	65	66	N.E.	Gentle.	N E.	Gentle.	N E.	Gentle.	Clear.	Clear.
" 22.	59	60	60	72	66	65	70	70	69	N.E.	Gentle.	N E.	Gentle.	N.E.	Gentle.	Clear.	Clear.
" 23.	56	64	63	82	72	70	79	69	68	S.W.	Gentle.	S.W.	Gentle.	S W.	Gentle.	Clear.	Clear.
" 24	54	59	58	63	64	63	62	64	63	N E.	Strong.	N.E.	Strong.	N.E.	Strong.	Clear.	Clear.
" 25.	50	60	55	73	69	63	76	67	66	N W.	Gentle.	N.W.	Gentle.	N.W.	Gentle.	Clear.	Clear.
" 26.	66	64	63	86	70	67	83	68	67	S.W.	Light.	S.W.	Light.	S.	Light.	Clear.	Clear.

"	27.	68	67	65	83	68	67	75	66	64	S.	Light.	S.	Light.	S.	Light.	Clear.	Clear.
"	28	66	64	64	79	65	64	63	65	63	S.	Calm.	S.	Calm.	S.	Calm.	Overcs't.	Raining
"	29.	64	65	65	67	66	65	66	66	66	N.E.	Light.	N E.	Light.	N.E.	Light.	Overcs't.	Overcs't
"	30.	65	64	63½	75	69	68	74	68	67	N.W.	Light.	N.W.	Light.	N.W.	Light.	Clear.	Clear.
May	1.	54	64	64	60	63	63	57	63	63	N.E.	Light.	N.E.	Light.	N E.	Light.	Overcs't.	Showery
"	2.	56	64	64	72	65	64	62	63½	65	N.E.	Light.	N.E.	Light.	N E.	Light.	Clear.	Clear.
"	3.	55	63	63	66	66	65½	64	67	66	E.	Light.	E.	Light.	S.E.	Light.	Clear.	Clear.
"	4.	66	65	65	80	68	67	70	65	66	S.	Strong.	S.	Strong.	S.	Strong.	Clear.	Clear.
"	5.	70	66	66	82	68	67	70	69	68	S.W.	Gentle.	S.W.	Gentle.	S.W.	Gentle.	Clear.	Clear.
"	6	68	65	65	82	71	69	69	71	70	S.E.	Gentle.	S.E.	Gentle.	S.E.	Gentle.	Clear.	Clear.
"	7.	68	67	67	61	67	67	60	68	67	N.E.	Strong.	N E.	Strong.	N.E.	Strong.	Raining.	Raining
"	8	56	63	64	67	66	65	62	64½	64	N.E.	High.	N.E.	High.	N E.	High.	Clear.	Clear.
"	9	56	64	62	67¾	63	63	60	64	64	N.E.	Gale.	N.E.	Gale.	N.E.	Gale.	Clear.	Clear.
"	10.	57	62	62	61	63	63	60	63	63	N.E.	Gale.	N.E.	Gale.	N.E.	Gale.	Overcs't	Overcs't.
"	11.	65	61	62	78	66	65	68	65	65	E.	Gentle.	S.E.	Gentle.	S.E.	Gentle.	Overcs't.	Overcs't

RECORD OF SHAD HATCHING OPERATIONS *conducted in Salmon Creek, Albemarle Sound, on the Steamer Lookout, at Avoca Wharf, from April 11th, 1879, to May 14th, 1879, on account of United States and Maryland Commissions, by John S. Saunders*—Continued.

Date.	Condition of		Name of Fisheries Visited.	No. of Hauls Attended.	Total Number of Fish Taken at Hauls Attended.			Ripe Fish. Shad.		Eggs Obtained.	Fish Hatched.
	Sky. 6 P. M.	Water.			Shad.	Herring.	Pounds of Rock.	Males.	Female.		
April 11.	.....	Muddy.	*A	1	199	600	.....	5	3	50,000	.....
" 12.	.....	Muddy.	A	1	438	6,000	.....	14	10	250,000	.....
" 14.	Thun, Lig & Rain.	Cloudy.	A	2	224	9,000	94	5	3	60,000	.....
" 15.	Clear.	Cloudy.	A	2	523	7,500	240	6	3	60,000	.....
" 16.	Cloudy & Raining.	Cloudy.	A2 SH1	3	734	17,000	225	7	3	60,000	.....
" 17.	Raining.	Cloudy.	A2 SH1	3	1,825	21,000	395	14	6	120,000	.....
" 18.	Overcast.	Cloudy.	A2 SH4	6	3,286	39,900	945	14	7	110,000	.....
" 19.	Clear.	Cloudy.	A2 SH3	5	1,112	30,000	856	6	3	50,000	.....
" 20.	Clear.	Clearing.	†.....	.....	.....	.....	.....	.....	.....	.....	.....
" 21.	Clear.	Clear.	A3 SH4	7	3,219	89,000	1,058	28	17	420,000	.....
" 22.	Clear.	Clear.	A2 SH2	4	808	40,500	650	15	10	240,000	.....
" 23.	Clear.	Clear.	A2 SH3	5	4,078	27,500	925	18	12	250,000	.....
" 24.	Clear.	Clear.	A2 SH3	5	2,133	24,500	1,080	39	25	605,000	140,000

"	25.	Clear.	Clear.	A1 SH2 P2	5	1,622	62,000	322	19	8	185,000	200,000
"	26.	Overcast.	Clear.	A3 SH3 P2	8	2,227	38,800	1,085	20	8	175,000	350,000
"	27.	Clear	Clear.	†								
"	28.	Clearing.	Muddy.	A4 SH2 P3	9	3,760	81,500	1,082	33	20	445,000	325,000
"	29.	Clear.	Muddy.	A2 SH2 P2	6	3,630	25,000	693	53	37	850,000	400,000
"	30	Clear.	Clearing.	A2 P1	3	1,469	66,500	240	37	25½	565,000	
May	1.	Showery.	Clearing.	A1 P2	3	1,960	148,000	410	24	17½	400,000	520,000
"	2.	Clear.	Clearing.	A1 P1	2	675	14,000	195	28	25	625,000	200,000
"	3	Clear.	Clearing.	A1 P2	3	488	71,000	300	13	10	250,000	150,000
"	4.	Clear.	Clear.	†								
"	5.	Showery.	Clear.	A1 SH2 P1	4	695	62,000	1,015	25	19	410,000	500,000
"	6.								Rock 2	Rock 2	Rock 1,000,000	
"	6.	Clear.	Muddy.	A1 SH2 P1	4	708	8,500	890	16	13	260,000	440,000
"	7.	Overcast.	Muddy.	A1 SH3	4	1,626	13,500	700	27	24	500,000	425,000
"	8.										25 p. c. bad eggs(dead.)	
"	8.	Clear.	Muddy.	A1	1	1,140	25,000	230	30	25	500,000	230,000
"	9.	Clear.	Muddy.	‡								
"	10.	Overcast.	Clear.	A2	2	842	17,500	340				
"	11.	Clear.	Clear.	†								
"	12.											665,000
"	13.											500,000
"	14.											250,000
					98	39,412	945,800	13,970	496	334	7,440,000	5,295,000

* Dr. Capehart has changed the name of *Sutton Beach* to AVOCA, and wishes it so entered.

† Sunday. Seines not worked.

‡ No Fisheries hauling. Heavy gale, N.E.

The U. S. Commissioner determined to rely entirely on the apparatus taken down by the Lookout for perfecting the eggs gathered at the North Carolina station. We, therefore, retained in Maryland waters, the barges which had been used in the shad-hatching operations, as we thus insured their being available at the opening of the spawning season at Havre de-Grace. They were anchored in the position held by them in previous years, in Spesutie Narrows; and on board was placed a portion of the hatching corps, with instructions to examine the fish daily taken by the haul seines and gill-nets and report the arrival of the first spawning fish. The first ripe female was secured on the 3rd of May.

From this time the corps continued the examination of the seines on Spesutie Island and some of the floating batteries on the Flats. They also examined nightly the shad taken with the gill-nets. Although the number of ripe fish varied each night, they increased gradually until about the 23rd of the month.

From this period up to the end of May the operators were more successful than at any other time.

An examination of the table will show that the temperature of the water varied from 68° to 72°; and during this period the number of eggs secured, each night, was over half a million.

Near the end of May a second barge, fitted with the machinery which had been used in Albemarle Sound, was ready for work; and, with a portion of the corps, was placed in charge of Mr. John S. Saunders, who had conducted the operations in North Carolina. This second machinery-barge was anchored in the channel, near the Old Bay-fishery, and the operators attached to it were instructed to examine the fish taken by the gillers in this inner channel and on the upper portions of the Flats.

The machinery-barge, which had been successfully worked the year previous, was kept in Spesutie Narrows, in the old quarters, and was placed in charge of Mr. F. N. Clark, an experienced fish culturist. The details of the operations at these two stations will be found in the accompanying tables.

The work of collecting the eggs and hatching them out was continued with great success until the 10th of June, when the fishing in Maryland waters ceases by limitation of law. During the forty-five days in which the work was conducted by Mr. Clark, the force under his direction examined numbers of shad, finding about 503 ripe females, from which they secured 11,015,000 eggs. Over 9,515,000 fish were produced from these eggs, and were either deposited in the local streams or shipped to other waters.

In the period of thirteen days consumed in similar work by the corps on machinery-barge No. 2, under Mr. John S. Saunders, of Baltimore, the men examined 4,859 shad, and found 112 ripe females. From these fish, by using the milt from 119 males, they obtained 1,900,000 eggs, hatching out 1,252,000 young fish, most of which were placed in local waters. The tables accompanying this report show in detail the work at the three stations.

On the 4th of May all the eggs secured before the close of the fishing season at Havre de Grace were hatched out, and the machinery and equipment towed to Baltimore harbor and stored. The estimates of eggs and fish were based on the supposition that a healthy ripe shad would produce 20,000 eggs. During the season Mr. Clark studied the subject with care. Having counted the number of eggs that would cover a square inch of space, and calculating therefrom the total yield of several good fish, he found that the average would be nearer 30,000 than 20,000. It has, however, been the custom with the Maryland Commission to take the last-mentioned number as the basis of calculation.

From an examination of the reports of the New York Commissioners, we find that they estimate the yield of shad on the Hudson River at a much higher figure.

Of the fish produced at Havre de Grace, 7,757,000 were deposited in the waters of Maryland.

RECORD OF SHAD HATCHING OPERATIONS *conducted at Spesutie Narrows, States and Maryland Fish Com*

Date.	Temperature of						Wind.			
	Air.	Surface water.	Air.	Surface water.	Air.	Surface water.	Direction.	Intensity.	Direction.	Intensity.
	6 A. M.		12 M.		6 P. M.		6 A. M.		12 M.	
May 1	....	....	....	57	....	....	.....	.....	.....	.....
" 2	....	....	....	58	....	....	.....	.....	.....	.....
" 3	....	....	....	60	....	....	.....	.....	.....	.....
" 4	....	....	....	57	....	....	.....	.....	.....	.....
" 5	....	....	....	61	....	....	.....	.....	.....	.....
" 6	....	....	....	62	....	....	.....	.....	.....	.....
" 7	....	....	....	63	....	....	.....	.....	.....	.....
" 8	....	....	....	65	....	....	.....	.....	.....	.....
" 9	....	....	....	64	....	....	.....	.....	.....	.....
" 10	....	....	....	62	....	....	.....	.....	.....	.....
" 11	....	....	....	62	....	....	.....	.....	.....	.....
" 12	....	....	....	65	....	....	.....	.....	.....	.....
" 13	....	....	70	67	....	....	.....	.....	S.	Light.
" 14	....	....	80	72	....	....	.....	.....	S.E.	Light.
" 15	....	....	76	72	....	....	.....	.....	S.W.	Strong.
" 16	....	....	82	73	....	....	.....	.....	S.E.	Light.
" 17	70	71	79	73	78	73	E.	Strong.	N.E.	Strong.
" 18	72	71	76	73	69	73	N.E.	Light.	N.E.	Light.
" 19	70	71	76	75	78	77	S.	Light.	S W.	Light.
" 20	69	71	79	75	76	75	S.	Light.	S.E.	Light.
" 21	69	70	76	76	70	75	S.W.	Light.	S.W.	Strong.
" 22	68	71	71	72	68	72	N.W.	Gale.	N.E.	Strong.
" 23	60	67	65	68	66	69	N.E.	Strong.	N E.	Strong.
" 24	66	64	68	66	65	68	S.W.	Light.	S.W.	Strong.
" 25	60	67	72	69	69	72	W.	Light.	S W.	Strong.
" 26	66	68	70	69	70	70	N.E.	Strong.	N.E.	Strong.
" 27	60	68	66	66	67	67	E.	Light.	S.	Strong.
" 28	66	66	74	69	70	70	N.	Strong.	N.E.	Light.
" 29	66	66	74	71	74	71	W.	Light.	S.W.	Light.
" 30	69	68	82	72	83	73	S.	Very Light	S.W.	Light.
" 31	73	71	80	75	90	75	S.	Light.	S.	Light.
June 1	75	74	86	77	93	82	S.W.	Very Light	S W.	Very Light
" 2	82	76	88	79	86	81	W.	Very Light	S.W.	Very Light
" 3	80	77	74	77	76	78	N.W.	Very Light	S.W.	Very Light
" 4	66	76	68	76	78	78	W.	Very Light	W.	Very Light
" 5	75	74	82	78	74	77	S.W.	Very Light	S.W.	Very Light
" 6	79	76	80	78	74	78	N.W.	Very Light	N.W.	Very Light
" 7	58	69	64	69	68	74	N.W.	Strong.	N.	Light.
" 8	74	72	78	73	80	76	N.	Very Light	N.W.	Very Light
" 9	75	73	76	74	85	78	N.E.	Very Light	S.	Very Light
" 10	76	74	82	78	79	77	S.W.	Very Light	S.	Fair.
" 11	74	75	85	79	74	77	S.W.	Fair.	S.W.	Fair.
" 12	70	75	78	78	78	79	S.W.	Light.	S.E.	Light.
" 13	73	76	77	78	74	76	N.W.	Strong.	N.	Strong.
" 14	69	75	78	78	....	....	N.	Strong.	S.	Fair.

on the Chesapeake Bay, from May 1st, 1879, to June 14th, 1879, on account of the United States Commission, by Frank N. Clark.

Direction.	Intensity.	Condition of Sky. 6 P. M.	Sky. 6 A. M.	Sky. 12 M.	Sky. 6 P. M.	Water.	Ripe Fish. Males.	Ripe Fish. Females.	Eggs Obtained.	Fish Hitch'd.
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	1	1	25,000	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	2	2	45,000	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	6	6	130,000	.....
.....	.....	.....	.....	.....	.....	.....	1	1½	35,000	.....
.....	.....	.....	.....	.....	.....	.....	5	5	110,000	.....
.....	.....	.....	.....	.....	.....	.....	2	2	45,000	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	15	15	325,000	.....
.....	.....	.....	Hazy.	.....	Clear.		8	8	170,000	.....
.....	.....	.....	Cloudy.	.....	Clear.		10	10	225,000	.....
.....	.....	.....	Clear.	.....	Clear.		9	9	190,000	.....
.....	.....	.....	Clear.	.....	Clear.		2	2	45,000	300,000
N.E.	Strong.	Cloudy.	Cloudy.	Cloudy.	Clear.		14	14	310,000	140,000
S.E.	Strong.	Cloudy.	Cloudy.	Cloudy.	Clear.		6	6	130,000	375,000
S.W.	Light.	Cloudy.	Clear.	Cloudy.	Clear.		10	10	225,000	300,000
S.E.	Light.	Cloudy.	Cloudy.	Clear	Clear.		14	14	310,000	200,000
N.E.	Gale.	Cloudy.	Clear.	Cloudy.	Clear.		.....	.....	.....	300,000
N.E.	Strong.	Clear.	Clear.	Clear.	Cloudy.		9	9	195,000	200,000
S.E.	Light.	Clear.	Clear.	Clear.	Clear.		22	22	475,000	100,000
S.W.	Strong.	Clear.	Clear.	Clear.	Clear.		27	27	590,000	150,000
N.W.	Strong.	Cloudy.	Clear.	Cloudy.	Clear.		30	30	660,000	100,000
N.	Light.	Clear.	Cloudy.	Cloudy.	Clear.		30	30	665,000	150,000
S.	Light.	Cloudy.	Cloudy.	Cloudy.	Clear.		36	36	795,000	100,000
S.	Light.	Clear.	Clear.	Clear.	Clear.		25	25	550,000	425,000
S.W.	Light.	Clear.	Clear.	Cloudy	Clear.		25	25	545,000	450,000
S.W.	Light.	Cloudy.	Clear.	Clear.	Clear.		27	27	600,000	950,000
S.W.	Very Light	Clear.	Clear.	Clear.	Clear.		15	15	330,000	900,000
S.W.	Very Light	Clear	Clear.	Clear.	Clear.		17	17	385,000	950,000
S.	Very Light	Clear.	Clear.	Cloudy.	Clear.		2	2	45,000	725,000
S.	Very Light	Cloudy.	Cloudy.	Cloudy.	Clear.		17	17	360,000	325,000
W.	Very Light	Slig'y C	Clear.	Clear	Clear.		30	30	665,000	150,000
N.	Strong.	Clear.	Clear	Cloudy.	Clear.		15	15	360,000	.....
N.W.	Strong.	Clear.	Clear.	Cloudy.	Clear.		10	10	225,000	100,000
N.W.	Light.	Clear.	Clear.	Clear.	Clear.		20	20	410,000	325,000
S.	Very Light	Clear	Clear.	Clear.	Clear.		11	11	255,000	300,000
S.	Very Light	Clear.	Clear.	Clear.	Clear.		6	6	115,000	275,000
S.	Fair.	Clear.	Clear.	Clear.	Clear.		.....	.....	.....	350,000
S.W.	Strong.	Clear.	Clear.	Clear.	Clear.		10	10	220,000	325,000
S.W.	Light	Clear.	Clear.	Clear.	Clear.		14	14	310,000	200,000
N.W.	Strong.	Clear.	Clear.	Clear.	Clear.		.....	.....	.....	100,000
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	250,000
							503	503	11,015,000	9,515,000

REMARKS.—Sent to Havre de Grace by Quinn 100,000; sent to Havre de Grace for Kumlein 50,000; station moved to Havre de Grace with 400,000 eggs on hand. Total 550,000.

RECORD OF SHAD HATCHING OPERATIONS *conducted at Old Bay Fishery, near Ha*
United States and Maryland F

Date.	Temperature of									Wind.					
	Air.	Surface Water.	Bottom.	Air.	Surface Water.	Bottom.	Air	Surface Water.	Bottom.	Direction	Intensity.	Direction.	Intensity.	Direction.	Intensity.
	6 A. M.			12 M.			6 P. M.			6 A. M.		12 M.		6 P. M.	
May 30							82	79	79					S. W.	Gent
May 31	75	79	78	82	79	79	84	80	80	S. W.	Gentle.	S. W.	Gentle.	N. W.	Gent
June 1	* 80	80	80	85	81	81	87	81	81	S. W.	Gentle.	S.	Gentle.	S.	Gent
June 2	71	80	80	88	81	81	86	82	82	N. E.	Gentle.	S. E.	Calm.	S. W.	High
June 3	† 74	80	81	74	80	80	71	80	80	Shifting	High.	Shifting	High.	Shifting	High
June 4	‡ 62	79	79	76	79	79	78	79	79	W.	Strong.	W.	Strong.	S. W.	Ligh
June 5	§ 64	76	76	81	79	78	82	80	79	S. W.	Light.	S. W.	Light.	S. W.	Ligh
June 6	69	78	78	82	80	80	72	78	78	N. W.	Light.	N. W.	Light.	N. W.	Ligh
June 7	‖ 58	68	68	71	74	74	70	76	76	N. W.	Light.	N. W.	Light.	N. W.	Ligh
June 8	¶ 60	74	74	74	75	75	82	78	78	S.	Light.	S. E.	Light.	W.	Ligh
June 9	** 6	72	72	8	76	76	8	79	79	S.	Light.	S.	Light.	S.	Ligh
June 10	†† 74	76	76	85	77	77	86	80	80	S.	Light.	S.	Light.	S.	Ligh
June 11	‡‡ 76	76	76	88	79	79	82	79	79	S.	Light.	S.	Light.	S.	Ligh
June 12															
June 13															

*One boat getting 12 female and no male, which accounts for [roportion of eggs to fish spawn
†Proportion of eggs to ripe fish caused by males being found by one boat and females in othe
‡Most of eggs badly impregnated in about 90,000 thought to be good.
§Female fish found in one boat and only one male to impregnate eggs.
‖Eggs badly impregnated.

Grace, Md., on the Machinery Barge No. 2, from May 30, 1879, to June 13, 1879, on account of missions, by John S. Saunders.

Condition of Sky.			Water.	State of Tide.			Total Fish Overhauled.	Ripe Fish.		Eggs Obtained.	Lost.	Fish Hatched.
A. M.	12 M.	6 P. M.		6 A.M.	12 M.	6 P.M		Males.	Females.			
.....	.....	Clear.	Clear.	.....	.....	.....	393	8	6	120,000	20,000	.....
ear.	Stormy.	Clear.	Clear.	Ebb.	Slack.	Flood	923	2	1	25,000	5,000	.....
ear.	Clear.	Clear.	Clear.	Flood	Flood	Ebb.	1578	13	15	185,000	50,000	.....
ear.	Clear.	O'ercast	Clear.	Flood	Ebb.	Ebb.	Heavy Storm.			No nets out.		120,000
ining	Raining	Raining	Clear.	Flood	Flood	Ebb.	397	8	5	45,000	5,000	.....
ear.	Clear.	Clear.	Clear	Flood	Ebb.	Flood	219	6	6	90,000	15,000	.....
ear.	Clear.	Clear.	Clear	Ebb.	Ebb.	Flood	178	2	7	25,000	3,000	.....
ear.	Clear.	O'ercast	Clear	Ebb.	Flood	Ebb.	177	10	10	215,000	55,000	.....
ear.	Clear.	Clear.	Clear.	Ebb.	Flood	Slack.	263	30	18½	380,000	80,000	135,000
ear	Clear.	Clear.	Clear.	Ebb.	Flood	Ebb.	220	11	8	175,000	100,000	.....
ear.	Clear.	Clear.	Clear.	Ebb.	Flood	Ebb.	230	16	19½	385,000	115,000	187,000
ear.	Clear.	O'ercast	Clear.	Slack.	Flood	Ebb.	149	8	8	95,000	.....	.....
ear.	Clear.	Clear.	Clear.	Flood	Slack.	Ebb.	132	5	8	160,000	.....	285,000
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	125,000
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	175,000
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	225,000
							4859	119	112	1,900,000	448,000	1,252,000

adly impregnated and injured by heat.
scarcity of male fish causing many eggs to be unimpregnated.
Transferred to steamer Lookout June 10.
Moved barge to Havre de Grace. Eggs transferred to steamer Lookout June 13.

A careful examination of these tables will show that much the larger proportion of ripe females was found among those taken by the gill-nets at the close of the season. This percentage may seem small, when we remember that for purposes of reproduction alone these migratory fish ascend the rivers. An explanation, however, of the comparatively insignificant numbers of ripe females taken is offered by the fact that the fish are not considered ripe or useful to the fish culturist until they are in the act of spawning or the eggs ready to run freely from them. A very large number of fish caught bear evidence of being near this state. These facts would seem to indicate that the work of hatching shad successfully and on a larger scale would be greatly facilitated by keeping over for a few days, until they become quite ripe, the fish taken just before they are ready to spawn. This plan has been pursued with several varieties of fish, notably with the salmon, which is taken in the spring of the year by pound nets in Penobscot Bay, and transferred thence to fresh water ponds some miles distant, and retained in these until the fall, by which time the eggs are in a proper state of development. The great difficulty with which we have to contend in this treatment of shad consists in the fact that they are so extremely delicate, their scales being easily knocked off, causing disease and death. We have suggested in a previous report the plan of penning the fish by such methods as are used for keeping white fish on Detroit River. In our first report we gave an account of the manner in which the fishing is conducted in the above-named river, and urged our fishermen to adopt the plan pursued with the white fish. Numbers of shad could be held over and sent to market from time to time. This plan we strongly recommended for the "floating batteries" operated at the "Head of the Bay," as enclosures for keeping the fish could be most successfully used in connection with these batteries. Should we succeed in inducing one of the battery owners at Havre de Grace to provide this attachment, we are sure it would enable us to secure a much larger number of spawning fish each year.

The following table shows that deposits of this fish have been made in almost every stream of the Eastern Shore, and in the principal streams of the Western Shore. The distribution to the Eastern Shore was under the personal direction and supervision of Col. Thomas Hughlett, one of the Commissioners of Fisheries.

In making this distribution, on the Western Shore we transferred 200,000 to the upper waters of the Potomac, near the Point of Rocks. Each season we have deposited a large number of them in the headwaters of this river, from Piedmont down to the Falls.

These fish will, doubtless, go down to the ocean; and upon returning as adult fish, for the purpose of reproduction, will make strenuous efforts to pass the Great Falls and other obstructions in the Potomac River. If proper artificial means are provided for their ascent, we are confident that, in a few years, shad and other migratory fish will be found in abundance, even as far as the headwaters of this stream. We propose to pursue, during the coming year, the same plan with the herring and rock, should they be hatched out in large numbers.

Two hundred thousand young shad were turned over to the Commissioners of Fisheries of Pennsylvania, and by them placed in the upper waters of the Susquehanna. We hoped, by such means, to induce the fish to ascend that stream and thereby extend their spawning grounds—a result which would not only greatly benefit the people living in the country drained by the upper portions of the river mentioned, but would also increase the number of fish captured by our own citizens in the vicinity of Havre de Grace.

RECORD OF DISTRIBUTION OF SHAD *made from May 16, 1879, to June 14, 1879, by the Maryland Commission, under direction of the Commissioners.*

Date.	Place Whence Taken.	No. of Fish.		State.	Introduction of Fish.			Transfer in charge of—
		Originally Taken.	Actually Planted.		Place.	Stream.	Tributary of—	
May 16.	Spesutie Narrows.	300,000	300,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U.S.&Md.Sd.H Fce.
May 17.	Spesutie Narrows.	140,000	60,000	Maryland..	Cordova Station	Miles Creek.....	Chesapeake Bay	Thos. Hughlett, Jr.
May 17.	Spesutie Narrows.	.....	80,000	Maryland..	Cordova Station	Wye Mills Creek.	Miles Creek....	Thos. Hughlett, Jr.
May 18.	Spesutie Narrows	150,000	150,000	Maryland..	Salisbury	Wicomico River..	Chesapeake Bay	Levin Campbell.
May 19.	Spesutie Narrows	225,000	115,500	Maryland..	Savage.....	Patuxent River...	Chesapeake Bay	J. F. Ellis.
May 19.	Spesutie Narrows.	.....	110,000	Maryland..	Laurel.....	Patuxent River...	Chesapeake Bay	J F. Ellis.
May 19.	Spesutie Narrows.	100,000	100,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
May 21.	Spesutie Narrows	25,000	25,000	Maryland..	Havre de Grace.	Susquehanna Riv.	Chesapeake Bay	U. S & Md.
May 21.	Spesutie Narrows.	100,000	100,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
May 24.	Spesutie Narrows	80,000	80,000	Maryland..	Federalsburg...	Nanticoke River..	Chesapeake Bay	Thos. Hughlett, Jr.
May 24.	Spesutie Narrows.	150,000	150,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U S. & Md
May 26.	Spesutie Narrows	150,000	100,000	Maryland..	Whaleysville. ..	Pocomoke River..	Chesapeake Bay	Levin Campbell.
May 26.	Spesutie Narrows.	.....	50,000	Maryland..	Near Berlin....	St Michael's Riv.	Chesapeake Bay	Levin Campbell.
May 26.	Spesutie Narrows	150,000	150,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U. S & Md.
May 27.	Spesutie Narrows.	100,000	100,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
May 28.	Spesutie Narrows.	125,000	125,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
May 29.	Spesutie Narrows	100,000	100,000	Maryland..	Henderson.....	Choptank River..	Chesapeake Bay	Thos Hughlett, Jr.
May 29.	Spesutie Narrows.	50,000	50,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
May 30	Spesutie Narrows.	200,000	140,000	Maryland..	Millington.....	Chester River	Chesapeake Bay	Levin Campbell.
May 30	Spesutie Narrows.	.....	60,000	Maryland..	Centreville.....	Corsica Creek....	Chester River..	Levin Campbell.

RECORD OF DISTRIBUTION OF SHAD *made from May* 16, 1879, *to June* 14, 1879, *by the Maryland Commission, under direction of the Commissioners*—Continued.

Date.	Place Whence Taken.	No. of Fish.		State.	Introduction of Fish.			Transfer in charge of—
		Orignl'y Taken.	Actually Planted.		Place.	Stream.	Tributary of—	
May 30.	Spesutie Narrows.	200,000	200,000	Maryland..	Spesutie Narro's	Susquehanna Riv	Chesapeake Bay	U. S. & Md.
May 30.	Spesutie Narrows.	150,000	150,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
May 31.	Spesutie Narrows.	200,000	100,000	Maryland..	Middletown....	Sassafras River...	Chesapeake Bay	Thos. Hughlett, Jr.
May 31.	Spesutie Narrows	.....	100,000	Maryland..	Middletown ...	Bohemia River...	Chesapeake Bay	Thos. Hughlett, Jr.
May 31	Spesutie Narrows	400,000	400,000	Maryland..	Battery Light..	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
June 1..	Spesutie Narrows.	40 000	40,000	Maryland..	Havre de Grace	Susquehanna Riv.	Chesapeake Bay	U S. & Md.
June 1..	Spesutie Narrows.	200,000	200,000	Maryland..	Elkton.....	Elk River	Chesapeake Bay	Thos. Hughlett, Jr.
June 1..	Spesutie Narrows.	300,000	300,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
June 1..	Spesutie Narrows.	400,000	400,000	Maryland..	Battery Light..	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
June 2..	Spesutie Narrows.	300,000	300,000	Maryland..	Port Deposit...	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
June 2..	Spesutie Narrows	200 000	200,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
June 2..	Old Bay Fishery..	120,000	120,000	Maryland..	Old Bay Fishery	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
June 3..	Spesutie Narrows.	300,000	150,000	Maryland..	Princess Anne..	Manokin River...	Chesapeake Bay	Thos. Hughlett, Jr.
June 3.*	Spesutie Narrows.	.....	125,000	Maryland	Newtown.....	Pocomoke River..	Chesapeake Bay	Thos. Hughlett, Jr.
June 3..	Spesutie Narrows.	150,000	150,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
June 4..	Spesutie Narrows.	175,000	175,000	Maryland..	Cockeysville ...	Gunpowder River.	Chesapeake Bay	Thos. Hughlett, Jr.
June 4..	Spesutie Narrows.	150,000	150,000	Maryland..	Battery Light..	Susquehanna Riv.	Chesapeake Bay	U. S. & Md
June 6..	Spesutie Narrows.	100,000	100,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U. S & Md.
June 7.†	Old Bay Channel.	85,000	85,000	Maryland..	Old Bay Fishery	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.

* Lost all the fish in one can.

† Station No. 2.

RECORD OF DISTRIBUTION OF SHAD *made from May* 16, 1879, *to June* 14, 1879, *by the Maryland Commission, under direction of the Commissioners*—Continued.

Date.	Place Whence Taken.	No. of Fish.		State.	Introduction of Fish.			Transfer in charge of—
		Orig'l'y Taken.	Actually Planted.		Place.	Stream.	Tributary of—	
June 8.*	Old Bay Channel.	175,000	175,000					
June 8..	Spesutie Narrows.	100,000	100,000	Maryland..	Relay Station..	Patapsco River...	Chesapeake Bay	Wm. Hamlen.
June 9..	Spesutie Narrows	137,000	137,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
June 10.	Spesutie Narrows	200,000	200,000	Maryland..	Old Bay Fishery	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
June 10†	Old Bay Channel.	125,000	125,000	Maryland..	Point of Rocks.	Potomac River...	Chesapeake Bay	J. F. Ellis.
June 10.	Spesutie Narrows	200,000	50,000	Maryland..	Patuxent.....	Patuxent River...	Chesapeake Bay	W. M. Russ.
June 10.	Spesutie Narrows.	.....	25,000	Maryland..	Federalsburg...	Nanticoke River..	Chesapeake Bay	Thos. Hughlett, Jr.
June 10	Spesutie Narrows.	.....	25,000	Maryland..	Airy's Station..	Transquaking Riv.	Chesapeake Bay	Thos. Hughlett, Jr.
June 10.	Spesutie Narrows.	.....	50,000	Maryland..	Cambridge	Blackwater River.	Chesapeake Bay	Thos. Hughlett, Jr.
June 10.	Spesutie Narrows.	.....	50,000	Maryland..	Hillsborough...	Tuckahoe River..	Chesapeake Bay	Thos. Hughlett, Jr.
June 10.	Spesutie Narrows.	150,000	150,000	Maryland..	Henderson.....	Choptank River..	Chesapeake Bay	Thos Hughlett, Jr.
June 11‡	Spesutie Narrows.	125,000	105,000	Maryland..	Battery Light..	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
June 11	Spesutie Narrows.	200,000	140,000	Maryland..	R. R. Crossing..	Gunpowder River.	Chesapeake Bay	N. Simmons.
June 11.	Spesutie Narrows.	160,000	160,000	.....	Upper	Waters of the	Susquehanna.	Penna Commission.
June 14.	Spesutie Narrows.	75,000	75,000	Maryland..	Little Falls	Potomac River...	Chesapeake Bay	J. F. Ellis.
June 14.	Spesutie Narrows.	200,000	200,000	Maryland..	Port Deposit...	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
	Barge No. 1.....	400,000	400,000	Maryland..	Havre de Grace.	Susquehanna Riv.	Chesapeake Bay	U S. & Md.
		7,862,000	7,757,000					

* 50,000 from Station No. 2. †50,000 from Station No. 2. ‡Nearly all in one can died.

‖ 60,000 fish lost before leaving Havre de Grace; balance, in good condition, turned over to Mr. Creveling, of Pennsylvania.

BROOK TROUT—(*Salvelinus fontinalis*).

In the Fall we contracted with the proprietors of the Ludlow Trout farm in Pennsylvania for one hundred thousand eggs of the brook trout. These were received on the thirtieth of November, 1878. Shortly after they were placed in the hatching-house in Druid Hill Park the eggs commenced to hatch. The fish were sufficiently advanced to be ready for issue by the nineteenth of February, when, in accordance with the usual custom, the distribution commenced. The accompanying tables show the details.

As there was an unusual mortality with the eggs, and with the young fish soon after they left the shell, only forty-seven thousand were delivered to the applicants. Quite a number of fish were kept, as usual, for experimental purposes. It was very important that we should thoroughly test, the capacities of the limited ponds adjacent to the hatching-house for keeping this variety of fish during the summer months, as it is necessary that we should raise a sufficient number of fish to furnish breeders enough to produce eggs adequate to supply the increasing demands for trout. The necessity for purchasing eggs from other establishments has been a considerable drain on the resources of the Commission.

If we can keep in a healthy condition a few hundred adult breeding fish in our own ponds, we could, without any additional expense, secure a large number of eggs for distribution each season. As a large proportion of the water used to supply the trout-ponds in Druid Hill Park is derived directly from the high service reservoir, it is liable to considerable elevation of temperature during the hot summer months, and this heat has been quite disastrous to our efforts hitherto.

If we cannot secure sufficient quantity of water at low temperature to enable us safely to keep the fish of this family in the ponds at Druid Hill Park, it will be necessary for us to secure another site where we can control an ample supply of colder water. During the winter months the water is all that can be desired, and we have been most successful at the hatching-house in perfecting the eggs and caring for the young

fish up to the time when it becomes necessary to transfer them to the waters for which they are intended. While hatching the eggs of the California salmon in hastily prepared apparatus in the headwaters of the Potomac, we secured a number of adult trout which have been placed in the ponds of Druid Hill Park. We hope to be more successful with these. Mr. Alexander Kent, in 1873, captured in the same locality a large number of trout, and successfully transferred them to ponds which he had prepared for their reception in Green Spring Valley. They soon became completely domesticated, and for some time Mr. Kent was quite successful in their propagation. Although this year's distribution was very much smaller than that of the previous years, yet many localities were reached and quite a number of applications were filled, which could not be met in the distribution of the year previous. As in several localities the introduction of brook trout is quite a doubtful experiment, we have decided to await the results of these experiments before making further expenditures.

Land-locked Salmon—(*Salmo salar sebago.*)

Our limited experiments in preceding years have demonstrated the capacity of the land-locked salmon to live in warmer waters than can be endured by the other varieties of the salmon family. As the land-locked salmon grow more rapidly and attain under ordinary circumstances a greater size than the brook trout, and as our experiments indicate that they are a hardier fish we have determined to devote more attention to their introduction. During the year we secured from the eggs presented to the commission by the United States commissioner twenty-six thousand five hundred, which were distributed as will appear in the accompanying table:

RECORD OF DISTRIBUTION OF LAND LOCKED SALMON *made from May 22d, 1879, to September 13th, 1879, by Maryland Commission, under direction of the Commissioners.*

Date of Transfer.	Place whence taken.	No. of Fish.		Introduction of Fish.			Transfer in charge of, or to whom given.
		Orignl'y Taken	Actually Planted.	Place.	Stream	Tributary of—	
May 22.	Druid Hill Hatching House.	750	750	Baltimore, Md.	Stream.	Beaver Dam Cr'k.	J. R. Mordecai.
" 30.		1,000	1,000	Cecil county.	"	Susquehanna R.	Thomas Grubb.
June 6.		500	500	Baltimore county.	Pond	Charles Run.	J. M. Pearce.
" 7.		8,000	8,000	Druid Hill Park.	Druid Hill Lake.	Water Works.	Frank Behler.
" 9		2,000	2,000	" "	" "	"	"
" 10.		2,000	2,000	" "	" "	"	"
" 12.		1,000	1,000	Westminster.	Pond.	Little Pipe Creek.	H. T. Weaver.
" 12.		2,000	2,000	Westminster.	Cobb's Branch.	Water Works.	W. A. Cunningham.
" 16.		1,000	1,000	Hampton, Baltimore county.	Pond	Gunpowder River.	John Ridgeley.
" 20.		500	500	Charles Street avenue.	Lake	Stony Run	J. A. Edmonson.
" 23.		500	500	Union Bridge	Pond	Big Pipe Creek.	Pemberton Wood.
" 23.		1,000	1,000	"	"	" "	J. S. Koontz.
July 3.		500	500	Reisterstown, Baltimore co.	Lake	Patapsco Falls	J. V. Brown.
Aug. 1.		1,000	1,000	Druid Hill Park	Druid Hill Lake.	Water Works.	Frank Behler.
" 5.		1,500	1,500	Burnsides, Baltimore county.	Green Spring Run.	Jones' Falls	S. M. Shoemaker.
" 9.		1,000	1,000	Baltimore	Lake	"	M. A. Leinkuhler.
Sept. 13.		250	250	Easton, Talbot county.	Pond	Miles Creek	J. T. Bartlett.
" 13.		250	250	" "	"	"	Jas. Tarbutton.
" 13.		500	500	" "	"	"	W. Collins
" 13.		250	250	" "	"	"	W. P. Wright.
" 18.		500	500	Druid Hill Park.	Druid Hill Lake.	Water Works.	Frank Behler.
" 18.		500	500	" "	" "	"	Frank Behler.
		26,500	26,500				

RECORD OF DISTRIBUTION OF BROOK TROUT *made from February 19th, 1879, to May 30th, 1879, by the Maryland Commission, under direction of the Commissioners.*

Date of Transfer.	Place whence taken.	No. of Fish.		Introduction of Fish.			Transfer in charge of, or to whom given.
		Orignl'y Taken.	Actually Planted.	Place.	Stream.	Tributary of—	
Feb. 19.	Druid H. Hatch'g House.	1,000	1,000	Union Bridge, Md.....	Little Pipe Creek...	Monocacy River..	Pemberton Wood.
" 28.		3,000	3,000	.....	N. Branch Patuxent.	Patuxent River...	A. B. Davis.
Mar. 7.		1,000	1,000	Carrolton, Md.....	Spring Run.....	Gunpowder	Henry Taylor.
" 19.		2,500	2,500	Baltimore county.....	"	Beaver Dam Cr'k.	George Brown.
" 21.		500	500	.....	.....	.....	John R. Long.
" 22.		500	500	Carrolton, Md.....	Beaver Run.....	Patapsco	J. W. Wilderson.
" 22.		2,000	2,000	"	"	"	W. S. Weaver.
" 22.		2,000	2,000	"	"	"	Wm Arbaugh.
" 25.		1,000	1,000	Amendale, Prince George co..	Spring Run.....	Patuxent	Admiral Ammen.
" 26.		900	900	Headwaters Wye River.....	Eastern Bay	Chesapeake Bay..	Thomas Hughlett.
" 26		1,000	1,000	Skipton.....	Hardcastle's Stream.	Wye River.....	" "
" 26.		800	800	"	Tavernus Branch.	"	" "
" 26.		700	700	"	Tanyards Branch.	"	" "
" 26.		600	600	Long Woods.....	Three Bridges.....	"	" "
" 26.		1,500	1,500	Cordosa	Hennington's Brnch	Choptank.....	" "
" 26.		2,000	2,000	Woodstack Branch	E ston.....	"	" "
" 26.		500	500	Trappe.....	Wright's Pond.....	"	" "
" 26.		500	500	"	Collins' Pond.....	"	" "
" 26.		500	500	"	Bartlett's Pond.....	"	" "
" 26		1,000	1,000	Balkun's P. O.....	Long Green Branch.	Gunpowder.	J. S. Gittings.
" 27.		7,000	7,000	Issued by Commissioner Hughlett.			

RECORD OF DISTRIBUTION OF BROOK TROUT *made from February 19th, 1879, to May 30th, 1879, by the Maryland Commission, under direction of the Commissioners*—Continued.

Date of Transfer.	Place whence taken.	No. of Fish.		Introduction of Fish.			Transfer in charge of, or to whom given.
		Orignl'y Taken.	Actually Planted.	Place.	Stream.	Tributary of—	
Mar 27.	.....	1,000	1,000	Carroll county	Pond.....	Meadow Branch..	Jacob Eckard.
" 27.	.....	1,000	1,000	St. Dennis, Baltimore county.	.....	Patapsco	John Donaldson.
" 27.	.....	1,000	1,000	Chestertown, Kent county...	Langsford Bay.....	Chester River....	J. Ringold.
" 28.	.....	1,000	1,000	Woodberry, Md.....	Bee Tree.....	Jones' Falls.....	Dr. D. S. Williams.
" 28.	.....	1,000	1,000	Chestertown, Kent county...	Radcliff's Pond.....	Chester River....	J. H. Sappington.
" 29.	.....	1,000	1,000	Liberty, Frederick county...	Israel Creek.....	Potomac.....	J. F. Eyler.
" 29.	.....	1,000	1,000	Denning's, Carroll county...	Sam's Creek.....	Monocacy.....	P. Bennett.
" 31.	.....	1,000	1,000	Timonium, Baltimore county	Pot Spring Branch .	Gunpowder.....	C. C. Poultney.
April 1	.....	1,000	1,000	Catoctin Furnace.....	Fishing Creek.....	Catoctin River...	W. H. Ward.
" 7.	.....	1,000	1,000	Green Spring Valley.....	Western Run.....	Jones' Falls	S. S. Stump.
" 22.	.....	1,000	1,000	Timonium, Baltimore county	Jones' Falls.....	Gunpowder.....	J. F. C. Talbot.
" 26.	.....	1,000	1,000	.....	Israel Creek.....	Potomac.....	E. B. Nicewaner.
" 26.	.....	1,500	1,500	McDonogh School.....	Horse-Head Run...	Gwynn's Falls ...	S. H. Tagart.
May 1.	.....	1,000	1,000	.....	Small Run.....	Patuxent.....	D. S Lyon.
" 3.	.....	500	500	.....	Pond.....	.....	R. Jones
" 22.	.....	1,000	1,000	Green Spring Valley.....	Beaver Dam Creek .	Jones' Falls.....	J. R Mordecai.
" 30.	.....	500	500	Frederick county.....	Pond	.....	W. C. Young.
		47,000	47,000				

California Salmon—(*Salmo quinnat.*)

We have in our previous reports given the reasons which induced us to devote ourselves assiduously to the establishment of this most valuable fish in Maryland waters.

The distribution of fish obtained from the eggs presented by the U. S. Commissioner in the fall of 1878 was not completed on the first of January, and therefore not detailed in our report of that date. In accordance with our understanding with the U. S. Commissioner, we sent some of the salmon hatched for him at the Druid Hill Hatching-House to southern waters. These transfers were in charge of the men in the employ of the Maryland Commission, but the expenses were paid by the U. S. Commission. The details of this distribution will be found in the subsequent table.

The remaining young fish, amounting in all to 62,236, were disposed of in the early portion of the year. These were considerably larger than those usually sent out from the hatching-house, as they had been fed for a considerable time. In this manner, by depositing the fish not only as soon as the umbilical sac is absorbed, but by keeping and feeding them some time before they are deposited in the stream for which they are intended, and after they have attained considerable size, we have endeavored to insure the survival of a sufficient number to make their presence felt when they returned as adults from the sea.

The total distribution of California salmon in Maryland waters during the year 1879 amounted to 315,236, making an aggregate deposit of 2,532,149 young fish in the rivers of Maryland since the organization of the Commission. Experience has shown that the salmon do not attain their growth or return from the ocean for the purpose of spawning before the fourth or fifth year. We have therefore not looked for any results from these deposits up to this time, but we should commence to receive the benefits of their return in the course of the next year or so. Should these experiments prove successful, this fish, which enters so largely into the productive value of the rivers flowing into the Pacific, will be a most val-

uable acquisition to our fish-food. The fact that this fish is found in waters very much warmer than those inhabited by their cousins in the Atlantic, induced us to devote our energies more particularly to them. But the return of the Penobscot salmon in the Delaware River, and the capture of a large Penobscot salmon near Spesutie Island, has given us more confidence in the adaptability of Maryland waters to the Eastern variety.

Hitherto we have hatched all of the eggs of the salmon family in the hatching-house at Druid Hill Park. When the young fish were sufficiently advanced to warrant their distribution, they were transferred to the upper waters of the streams of the State, and in the distributions we have endeavored to reach points as high up the streams as practicable, where the water was colder and more likely to fill the requirements of the young fish. These transfers were attended with considerable labor and difficulty, and sometimes with some loss of fish. We therefore deemed it of sufficient importance to establish a temporary station at the head waters of the Potomac, where the fish intended for that stream could be hatched and turned loose in the river adjacent to the hatching-station. By this method we would avoid the necessity of moving the fish and endangering their safety. Accordingly, on the arrival of 500,000 eggs issued to the Maryland Commission by the U. S. Commissioner, we transferred 200,000 of them to the upper waters of the Potomac, in Garrett County, where we improvised a temporary hatching-station. The locality selected was on a farm belonging to Judge Dobbin, known as Kitzmiller's farm, on the north branch of the Potomac, several miles above Fort Pendleton. A pool immediately below a fall of about four feet in the river was selected. In this pool were placed a number of floating barges, in which trays containing the eggs were deposited. The water from above the falls was led to these barges by a trough properly protected by wire grating which discharged the water on the top of barges, the latter being provided with wire bottoms so that the water passed through the trays and out at the bottom. The trough and barges were so arranged that they would rise or

fall with the water in the river. In this manner we thoroughly guarded against any disaster from freshets or a sudden fall of the river. An examination of the accompanying table will show how successful the experiment was, and how small the daily losses of eggs. The experiment demonstrated how practical it is to hatch the eggs and care for the fish until the sac is absorbed without the expensive adjunct of an elaborate hatching-house. With the experiences of this season we are convinced that the most effectual means of stocking streams, with fish not easily accessible by rail and wagon, is to pursue methods similar to those above described. It is entirely practicable with an equipment which can readily be carried in a wagon to organize a hatching station where pure and wholesome water can be found, almost as quickly as a tent can be pitched, and that, too, on a scale sufficient to provide for a half million trout eggs. It will be observed that those fish kept in the warmer waters of Druid Hill Park were hatched and ready for distribution by the twenty-sixth of November, about the time the eggs which were hatching in the upper waters of the Potomac were freed from the shell, showing a retardation of about one month by the employment of the cold mountain water. When the development proceeds slowly, the young fish are more vigorous than those from rapidly hatched eggs. These experiments would indicate that better results would hereafter be obtained by seeking those localities with colder water. All of the fish obtained from the 200,000 eggs transferred to the hatching-station in the north branch of the Potomac were turned loose in the river. The details of the distribution obtained from 300,000 eggs retained at the Druid Hill Hatching-House will be found in the accompanying table.

The table showing the average temperature of air and water at Druid Hill Park for each month during the year, and the summary of the monthly loss and distribution of fish will also be found.

RECORD OF DISTRIBUTION OF CALIFORNIA SALMON *made on January 6th, 1879, by the United States Fish Commission, under direction of Maryland Commissioners.*

Date of Transfer.	Obtained from	Place whence taken.	No. of Fish.		Introduction of Fish.			Transfer in charge of, or to whom given.
			Orignl'y Taken.	Actually Planted.	Place.	Stream.	Tributary of—	
Jan'y 6.	U.S.F C.	Druid Hill Hatching H.	1,500	1,500	Charlotte, N. C.....	Catawba River.	Santee.....	Wm. H. Busch.
" 6.	McLoud River, Cal.	"	4,500	4,500	R. R. Crossing.....	Broad River....	"	" "
" 6.	"	"	4,500	4,500	Spartansburg C. H.....	Pacolett.....	"	" "
" 6	"	"	4,500	4,500	Easley, S. C.....	Saluda River...	"	" "
" 6	"	"	5,000	5,000	Orangeburg, S. C.....	Edisto River...	Ocean	Wm. Hamlen.
" 6.	"	"	5,000	5,000	Biggins Church, S. C.....	Cooper River...	"	" "
			25,000	25,000				

RECORD OF CALIFORNIA SALMON HATCHING OPERATIONS *conducted at* *October* 15, 1879, *to November* 26, 1879, *on account of Maryland*

Date.	Temperature of Air.			Temperature of Surface Water.			Wind. Direction.			Wind. Intensity.		
	6 A. M.	12 M.	6 P. M.	6 A. M.	12 M.	6 P. M.	6 A. M.	12 M.	6 P. M.	6 A. M.	12 M.	6 P. M.
Oct. 15..	....	75	62	....	58	58	.....	.....	.....	.....	.....	Calm.
Oct. 16..	48	80	64	54	59	60	.....	S. W.	S. W.	Calm.	Light.	Light.
Oct. 17..	47	58	63	53	56	53	N. W.	N. W.	N. W.	Light.	Light.	Light.
Oct. 18..	59	59	60	57	59	59	N. W.	N. W.	N. W.	Calm.	Light.	Light.
Oct. 19..	47	48	46	54	53	53	N. E.	N. E.	N. W.	Light.	Light.	Strong
Oct. 20..	34	61	47	45	47	49	.....	N. W.	N. W.	Calm.	Fresh.	Fresh.
Oct. 21..	41	50	49	45	48	47	N. E.	N. E.	N. W.	Light.	Light.	Light.
Oct. 22..	40	55	58	45	48	50	N. W.	N. W.	N. W.	Light.	Light.	Light.
Oct. 23..	54	52	43	51	51	50	N. W.	S. E.	N.	Fresh.	Fresh.	Fresh.
Oct. 24..	35	36	33	43	42	41	N. E.	N.	N.	Fresh.	Strong.	Strong
Oct. 25..	22	42	36	35	38	39	N. W.	N. W.	N. W.	Light.	Light.	Light.
Oct. 26..	19	45	41	33	36	39	N. W.	N. W.	N. W.	Light.	Light.	Light.
Oct. 27..	32	50	45	35	40	41	N. W.	S. W.	S. W.	Light	Light.	Light.
Oct. 28..	45	46	43	41	42	42	N. W.	N. W.	N. W.	Strong.	Strong.	Strong
Oct. 29..	39	60	50	46	44	45	N. W.	N. W.	N. W.	Strong.	Strong.	Strong
Oct. 30..	46	55	42	44	43	40	N. W.	N. W.	N. W.	Strong.	Strong	Light.
Oct. 31..	35	44	32	36	42	38	N. W.	N. W.	N. W.	Strong.	Strong.	Light.
Nov. 1..	30	36	32	34	35	34	N. W.	N. W.	N. W.	Light.	Strong.	Strong
Nov. 2..	20	34	35	32	34	35	N. W.	N. W.	S. E.	Light.	Light.	Strong
Nov. 3..	22	23	22	33	33	33	N. E.	N. E.	N. E.	Strong.	Strong.	Strong
Nov. 4..	21	25	24	33	33	33	N. W.	N. W.	N. W.	Strong.	Strong.	Strong
Nov. 5..	13	35	34	32	33	33	N. W.	N. E.	N. E.	Strong.	Strong.	Light.
Nov 6..	31	35	35	33	33	33	S. W.	S. W.	S. W.	Light.	Light.	Light.
Nov. 7..	35	42	37	33	33	33	N. W.	N. W.	N. W.	Light.	Light.	Light.
Nov. 8..	36	43	42	33	34	34	N. W.	S. W.	S. W.	Light.	Light.	Light.
Nov 9..	47	61	54	37	42	41	.....	N. W.	N. W.	Calm.	Light.	Light.
Nov. 10	51	.....	.....	43	.....	.....	N. W.	.....	.....	Light.	.....	.....
Nov. 18.	From Nov. 10th to Nov. 18th, the number of dead eggs was.....											
Nov. 26.	The total number of dead eggs from Nov. 18th to the 26th, when all were hatche the river, was.....											

The number of eggs were estimated to be 200,000. The weather becoming very cold, their protection, it was deemed advisable to put 50,000 of the eggs, which were about protected places as hatched.

Judge Dobbin's farm, Garrett County, on the North Branch of the Potomac River, from Fish Commission, by Wm. Hamlen and Wm. P. Sauerhoff.

Condition of Sky.			Number Lost.	REMARKS.
6 A. M.	12 M.	6 P. M.		
.....	.....	Clear.	.....	Eggs received at 1.30 P. M.
Cloudy.	Clear	Clear.	760	[ished laying out the eggs.
Cloudy.	Cloudy.	Cloudy.	5,280	6040 dead eggs found on unpacking. Rain 2 P. M. Fin-
Cloudy.	Cloudy.	Cloudy.	457	River raised ½ inch.
Cloudy.	Cloudy.	Clear.	320	Rain stopped 1.30 P. M.
Clear.	Clear	Clear.	314	
Cloudy.	Cloudy.	Cloudy.	298	Rain 7 A. M. Stopped 5.30 P. M.
Clear.	Clear.	Clear.	233	River raised 1½ inches.
Cloudy.	Cloudy.	Cloudy.	288	Rain 6.45 A. M. Stopped 4.20 P. M.
Cloudy.	Cloudy.	Cloudy.	215	River fell 2 inches. Snow 7.30 A. M. Stopped 3.10 P. M.
Clear.	Clear.	Clear.	183	Ice on river.
Clear.	Clear.	Clear.	117	Had to break ice on hatching box so as to get the trays out to pick over the eggs.
Cloudy.	Cloudy.	Cloudy.	194	
Cloudy.	Cloudy.	Cloudy.	181	*Rain* 3.15 A. M. *Hail* 9 A. M. *Snow* 10 A. M. Cleared up 3.20 P. M.
Clear.	Clear.	Clear.	164	
Cloudy.	Clear.	Clear.	149	
Cloudy.	Clear.	Clear.	137	
Clear.	Clear	Clear.	127	
Clear.	Cloudy.	Cloudy.	.....	Eggs not picked on account of ice. Snow 6.15 P. M.
Cloudy.	Cloudy.	Cloudy.	.....	Eggs not picked on acc't of ice. Stopped snowing 6.30 P. M.
Cloudy.	Cloudy.	Cloudy.	.....	Eggs not picked on acc't of ice. Ice on river 1¼ in. thick.
Cloudy.	Cloudy.	Cloudy.	.....	Eggs not picked on acc't of ice. Snow and hail 7.15 P. M.
Cloudy.	Cloudy.	Cloudy.	42	Stopped snowing 3 A. M. Snow and rain from 7 A. M. until
Clear.	Clear.	Clear.	58	River raised 8 in. at 6 A. M., 12 in. at 11 A. M. [6.30 P. M.
Cloudy.	Cloudy.	Cloudy.	546	River fell 4 in. 6 A. M.
Cloudy.	Cloudy.	Cloudy.	161	River fell 3 in. 6 A. M.
Cloudy.	.....	.....	.....	River fell 2 in. 6 A. M.
.....	.....	.....	1,900	
and the fish turned into				
.....	.....	.....	600	From Nov. 10th to Nov. 18th the number of fish turned out was 76,300.
			12,724	

the location of the tent exposed, and the men not provided with the necessary appliances for batching, into the stream. The young fish and the balance of the eggs were liberated in

RECORD OF DISTRIBUTION OF CALIFORNIA SALMON *made from February 1st, 1879, to December 24th, 1879, by the Maryland Commission, under direction of the Commissioners.*

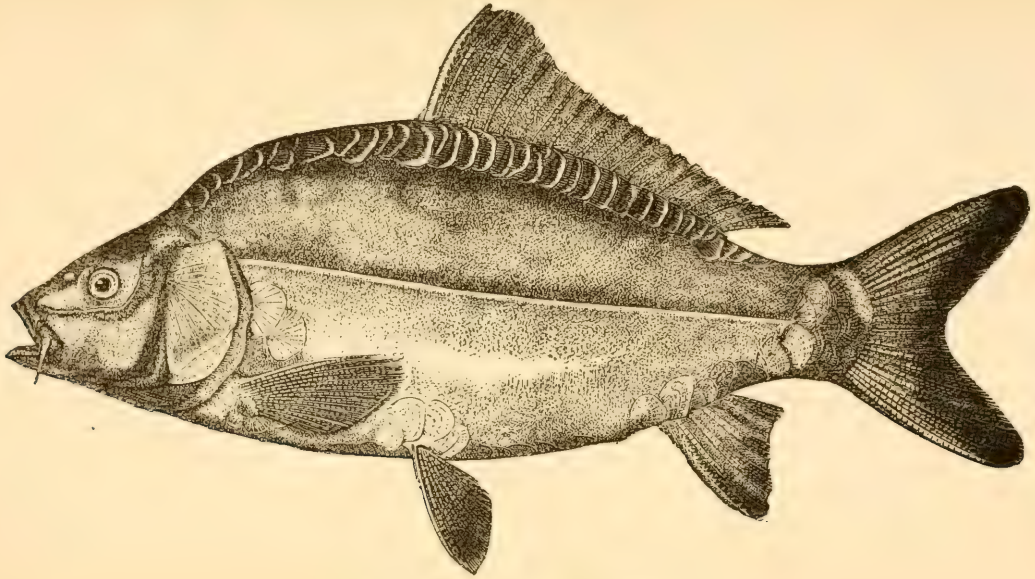
Date of Transfer.	Obtained from	Place whence taken.	No. of Fish.		Introduction of Fish.			Transfer in Charge of, or to Whom Given.
			Orign'ly Taken.	Actually Planted.	Place.	Stream.	Tributary of	
Feb. 1..	U. S. F. Com.	Druid Hill Hatching House.	4,000	4 000	Wilna, Harford Co....	Winter's Run	Bush River.....	E. Hollingswirth.
Feb. 1..	" " McCloud River, California.	" "	10,000	10,000	Savage Station.....	Patuxent.....	Patuxent.....	
Feb. 13.	" " " "	" "	12,000	12,000	Millington.....	Chester River.....	Chesapeake Bay..	Thos. Hughlett.
Feb. 21.	" " " "	" "	8,000	8,000	Henderson, Caroline C.	Choptank River....	Chesapeake Bay..	Thos. Hughlett.
Feb. 24.	" " " "	" "	7,000	7,000	.....	.....	.....	Wm. Hamlen.
Feb. 26.	" " " "	" "	3,000	3,000	Cambridge...	Black Water.....	Tangier Sound....	W. H. Jenkins, Jr.
Feb. 26.	" " " "	" "	3 000	3,000	.....	Chickacomico.....	Transquaking Riv.	Thos. Hughlett.
Feb. 26.	" " " "	" "	3,000	3,000	Airey's Sta., Dor. Co..	Transquaking River	Tangier Sound ...	Thos. Hughlett.
Feb. 28	" " " "	" "	12,000	12.000	Hood's Mills & Airey.	Patapsco & Patuxent	Chesapeake Bay..	
June 6..	" " " "	" "	236	236	.....	.....	.....	
Nov. 26.	" " " "	" "	15,000	15,000	Parkton, Md.....	Big Gunpowder....	Chesapeake Bay..	Wm. Hamlen.
Nov. 29.	" " " "	" "	15,000	15,000	Parkton, Md.....	Deer Creek.	Susquehanna Riv.	Wm. Hamlen.
Dec. 4..	" " " "	" "	20,000	20,000	Laurel, Md.....	Patuxent.....	Chesapeake Bay..	W. H. Jenkins, Jr.
Dec. 4..	" " " "	" "	20,000	20,000	Savage.....	Middle Patuxent...	Patuxent.....	W. H. Jenkins, Jr.
Dec. 5..	" " " "	" "	5,000	5,000	Federalsburg, Dor. Co.	Nanticoke.....	Chesapeake Bay..	Thos. Hughlett.
Dec. 5..	" " " "	" "	1,000	1,000	Linkwood, Dor. Co...	Transquaking River	Tangier Sound...	Thos. Hughlett.
Dec. 5..	" " " "	" "	1,500	1,500	Fleming's Mill, Dor.Co	Chickacomico.....	Transquaking Riv.	Thos. Hughlett.
Dec. 5..	" " " "	" "	1,500	1,500	Barn's Farm, Dor Co.	Black Water.....	Tangier Sound ...	Thos. Hughlett.
Dec. 9..	" " " "	" "	6,000	6,000	D. Grue's Mill, Cecil C.	Octarora.....	Chesapeake Bay..	Thos. Hughlett.
Dec. 9..	" " " "	" "	5,000	5,000	Henford's M., Cecil C..	East River.....	Chesapeake Bay..	Thos. Hughlett.
Dec. 10.	" " " "	" "	6,000	6,000	St. Mark, Cecil Co....	Big Elk River.....	Chesapeake Bay..	
Dec. 10.	" " " "	" "	5,000	5,000	Millington, Kent Co ..	Andover Branch....	Chester River.....	Thos. Hughlett.
Dec. 10.	" " " "	" "	15,000	15,000	Harper's Ferry.....	Potomac.....	Chesapeake Bay..	Wm. Hamlen.

RECORD OF DISTRIBUTION OF CALIFORNIA SALMON *made from February 1st, 1879, to December 24th, 1879, by the Maryland Commission, under direction of the Commissioners*—Continued.

Date of Transfer.	Obtained from	Place whence taken.	No. of Fish.		Introduction of Fish.			Transfer in Charge of, or to Whom Given.
			Orign'ly Taken.	Actually Planted.	Place.	Stream.	Tributary of	
Dec. 11.	McCloud River, California.	Druid Hill Hatching House.	10,000	10,000	Hood's Mills	Patapsco	Chesapeake Bay	Wm. Hamlen.
Dec. 11.	"	"	10,000	10,000	Mount Airey	Little Patuxent	Chesapeake Bay	W. H. Jenkins, Jr.
Dec. 12.	"	"	1,000	1,000	Humpry's Lake, Salis'y	Wicomico Creek	Wicomico River	Thos. Hughlett.
Dec. 12.	"	"	4,000	4,000	Salisbury, Md	Wicomico Creek	Wicomico River	Thos. Hughlett.
Dec. 12.	"	"	2,000	2,000	Whalesville, Wor. Co.	Pocomoke	Chesapeake Bay	Thos. Hughlett.
Dec. 12.	"	"	2,000	2,000	Berlin	Trappe	Choptank River	Thos. Hughlett.
Dec. 12	"	"	2,000	2,000	Berlin	Herring Creek	Atlantic Ocean	Thos Hughlett.
Dec. 13	"	"	10,000	10,000	Hagerstown	Antietam	Potomac	W. H. Jenkins, Jr.
Dec. 13.	"	"	10 000	10,000	Hagerstown	Conococheaque	Potomac	Wm. Hamlen.
Dec. 15.	"	"	10 000	10,000	W. Md. R. R. Crossing	Big Pipe Creek	Monocacy	W H. Jenkins, Jr.
Dec. 15.	"	"	10,000	10,000	Mechanicstown	Owen's Creek	Monocacy	Wm. Hamlen.
Dec. 15.	"	"	5,000	5,000	Tank Station	North Patapsco	Patapsco	Wm. Hamlen.
Dec. 16.	"	"	10,000	10 000	Parkton	Deer Creek	Susquehanna	
Dec. 16.	"	"	1,000	1,000	Sandy Branch	Sassafras	Chesapeake Bay	Thos. Hughlett.
Dec. 16.	"	"	1 000	1 000	Kennedy's Pond, K't C.	Bohemia	Chester River	Thos Hughlett.
Dec. 16.	"	"	6 000	6 000	Carter's Bridge	Great Choptank	Chesapeake Bay	Thos Hughlett.
Dec. 17.	"	"	10,000	10,000	Cockeysville	Gunpowder	Chesapeake Bay	Wm Hamlen.
Dec. 18.	"	"	10,000	10,000	Laurel	Patuxent	Chesapeake Bay	Wm. Hamlen.
Dec. 18.	"	"	10,000	10,000	Savage	Middle Patuxent	Patuxent	Frank Behler.
Dec. 23.	"	"	10,000	10,000	Towsontown	Gunpowder	Chesapeake Bay	Wm. Hamlen.
			312,236	312,236				

Summary of Operations at Hatching House, Druid Hill Park, for 1879.

Month.	Average Temperature at Noon of—				California Salmon.			Land Lock Salmon.			Trout.		German Carp.		Penobscot Salmon.	
	Air.	Water. Hydrant.	Water. Spring.	Water. Pond.	Number of Eggs received.	Number of Fish or Eggs lost.	No. distributed.	Number of Eggs received.	Number of Fish or Eggs lost.	No. distributed.	Number of Fish or Eggs lost.	No. distributed.	Number of Fish or Eggs lost.	No. distributed.	Number of Eggs received.	Number of Fish or Eggs lost.
January.....	32.1	35 18	54.	35.13	.....	2,734	29,000	.....	.....	.....	10,269	.....	.....	.....	.....	.....
February....	32.19	35.16	51.12	35.14	.....	761	62,030	.....	.....	.....	43,246	4,000	.....	.....	.....	.....
March	49.5	45.25	49.23	43.23	.....	303	.....	.....	.....	.....	1,615	34,500	.....	.....	.....	.....
April.....	48.1	46.2	48.4	46.13	.....	2,354	.....	50,000	6,147	.....	4,510	5,500	.....	.....	.....	.....
May	68.	63.10	52 11	51.	.....	7,249	.....	.....	4,170	1,750	5,746	3,000	.....	.....	.....	.....
June	77.12	68.9	56.20	65.26	.....	399	236	.....	4,168	18,500	40	.....	.....	.....	.....	.....
July.....	82.21	76.13	59.23	75 30	.....	14	.....	.....	8,832	500	24	.....	.....	.....	.....	.....
August.	78.12	79.	61.85	75.21	.....	63	.....	.....	4,366	3,500	01	.....	.....	.....	.....	.....
September..	69 15	68.27	60.15	69.15	.....	.....	.....	.....	216	2,250	.....	.....	.....	.....	.....	.....
October.....	60 21	65 24	59 26	64.22	300,000	33,086	.....	.....	128	.....	.....	.....	.....	.....	.....	.....
November...	48.2	49.23	57.10	50.2	.... ..	4,013	30,060	.....	.....	.....	.....	.....	.....	3,490	.....	.....
December...	44.10	45 12	53.19	45 01	... ...	2,616	220,000	.....	03	.....	.....	.....	23	2,645	62,500	314
					300,000	53,442	341,236	50,000	28,030	26,500	65,451	47,000	23	6,135	62,500	314



LEATHER CARP.

Carp—(*Cyprinus carpio.*)

In our previous reports we have recorded the successful importation of the German carp. We are now able to present some of the good results therefrom. The fish left in our care by the U. S. Commissioner, as stated in our report, January, 1879, were not placed in the ponds constructed for their reception until late in the spring. It was not thought advisable to draw the water from but one of these ponds in the fall, but from the one drawn we secured about 7,000 young fish for distribution. This fish is especially adapted for small ponds, and is essentially a domestic fish, we were desirous, therefore, to issue them in small numbers and to those wishing to cultivate them in artificial ponds. We deemed it advisable to notify the people of the State, through the principal papers, that upon application at the Druid Hill Hatching House, ten pairs of this fish would be given to every person desiring to stock a pond within the limits of the State. The carp is exceedingly prolific, one of four or five pounds weight producing from 400,000 to 500,000 eggs. One of double the weight mentioned would yield at least 1,500,000 eggs, the number allowed for stocking a pond was, therefore, considered ample, their offspring would soon be numerous enough to stock a considerable lake.

Under this system of distribution seventy-five persons have been supplied up to this time.

The demand for carp not being as great as was anticipated —our people evidently not appreciating its great value as a food-fish, and one eminently qualified for domestic purposes, we arranged with the U. S. Commissioner to supply him with 3500 for present distribution. That number was, accordingly, turned over to his messengers, with the understanding that in return for them the State of Maryland was to receive other fish when the National Carp Ponds at Washington were drawn. As the fish in the Washington ponds are of the *leather carp* variety, which is greatly superior to the *scale-carp*—of which the greater part of those in Druid Hill Park consist—we hope to be able in the spring to distribute the more valuable

species. In order to familiarize our citizens with this fish—which is almost unknown in this country—and enable them to appreciate its full value, we give a detailed description of it, and a cut representing a "*leather-carp.*" We are indebted to the American Agriculturalist, whose editor was furnished with a drawing of one of the *leather carp* from our National Ponds. The electrotype is a reproduction from the illustration given in the January number of that periodical. The carp has been known for centuries in most of the countries of Europe, but has been chiefly cultivated in Germany and Austria. In England and France, although well known, it has not been bred with the care bestowed in the last mentioned countries, where it has attained considerable excellence, and where several varieties of it are to be found, viz: the *scale-carp*, which strongly resembles the original form, imported from Asia centuries ago; the *mirror-carp*, which is almost destitute of scales, and the Leather-carp, which is the most esteemed of the three varieties. It will be observed, see the accompanying engraving, that it is almost entirely devoid of scales, having only *one* row in the dorsal region, and a few near the fins. We have bestowed much care upon the carp, deeming its introduction into Maryland waters of great importance, as it is easily propagated, very prolific, a vegetable feeder, and capable of living in water subject to extreme elevations of temperature. We believe it to be peculiarly adapted to the eastern and southern portions of the State.

The fact of its being a vegetable feeder is an important point in its favor, as such fish can exist and thrive in water in which carnivorous fish would perish for lack of food. It has been noticed in the National Ponds at Washington that the fish feed voraciously and grow fat on the *alga*, commonly called frogs-spittle, which is found, in abundance, in still, or partially stagnant, waters. It also feeds on the worms, and the insects, *larvæ*, which they obtain by rooting in the mud.

It is said that in Europe large numbers are raised on the refuse matter from kitchens, slaughter houses and breweries. We have mentioned the capacity of this fish to survive extreme elevations of temperature, and to thrive in stagnant

water. We should add that it can live in water which at times may become very cold. As soon as the temperature of the water in which it is falls to 39° or 40° (Fahrenheit) it burrows into the mud and soft bottom, where it remains in a semi torpid state until the return of warm weather revives it. During this period, although it does not take food, it is said not to lose flesh. On account of this peculiarity of the carp, the ponds used for rearing it should have muddy bottoms, and should also be furnished with aquatic plants, especially those producing seed, which ripen and fall into the water.

The carp spawns in the spring and summer, sometimes extending its breeding season into the fall months.

The eggs produced attach themselves to the aquatic plants, as above-mentioned, and they hatch in from one to two weeks, according to the temperature of the water. Sudden changes of weather, from warm to cold, often prove fatal to the eggs.

Where the ponds are not amply provided with vegetable growth, and especially seed-bearing plants, this fish may be fed with crumbs of bread, leaves of cabbage, and almost any other kind of vegetable used by man; as well as with rice, corn, and cereals of every description, either whole or ground. Grain is, however, improved by being boiled in plain water.

The eggs—which are a favorite food with other fish—attach themselves as above-mentioned, to twigs and aquatic plants, and are consequently very accessible. For this reason, no other varieties of fish should be allowed in the ponds used for breeding purposes.

The ponds intended by the U. S. Commissioner at Washington to receive a portion of the imported fish (which were temporarily deposited in the ponds of Druid Hill Park) are constructed on the best principles, and have proved very successful. We, therefore, deem it proper to give a description of them, in order that they may serve as models after which ponds may be prepared by persons desirous of engaging in carp culture.

In the accompanying cut, a portion of the largest pond (represented by *I*) is shown. *L* and *K* are smaller ones on

either side of an island which contains the ponds devoted to breeding purposes.

There is nothing special to attract our attention in the construction of these three ponds, except the depressions near the outlet (known as collectors or kettles), into which the fish are gradually drawn when the water is taken from the ponds.

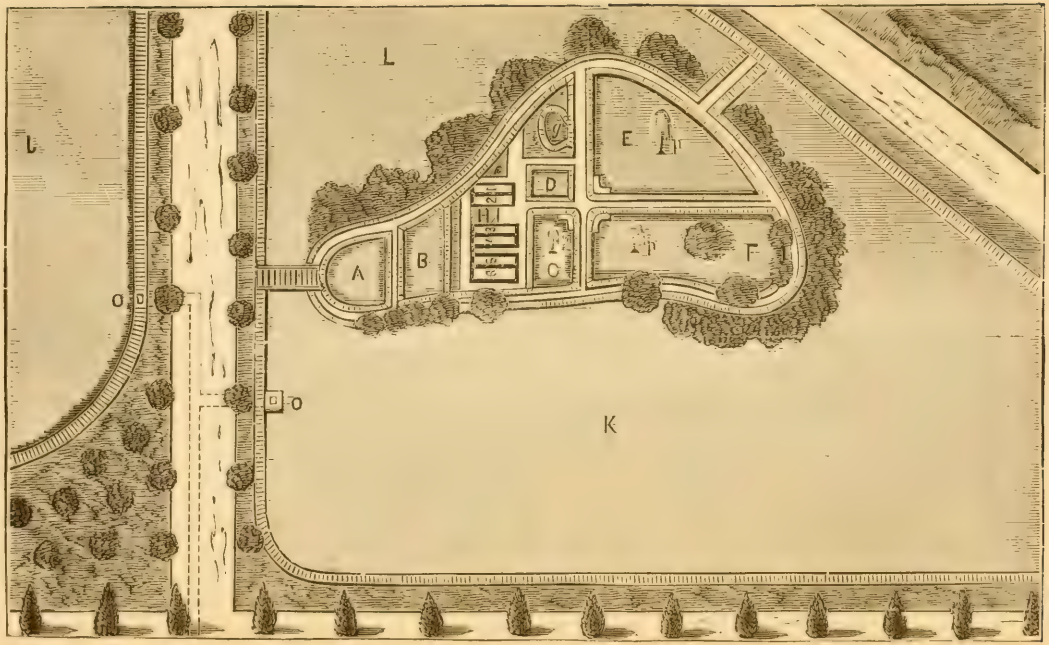
The ponds marked *a*, *b*, *c*, *d*, *e* and *f*, are used exclusively for breeding purposes. The outlet of each of these ponds connects with a drain-pipe which discharges itself into the Potomac River. At the outlet of each there is a kettle, as in those just mentioned, in which the fish are collected.

These ponds are not level, sloping from two inches to to four feet (in depth), the deepest parts being at the collectors. They are well furnished with aquatic plants, and a portion of those marked *a* and *b* are provided with movable partitions constructed in the shallow parts. These separate the more open space of the pond from that of a denser aquatic growth. The spawning fish eagerly seek those portions well provided with grasses, and after depositing their eggs they are allowed to return to the more open space. The partitions are then put in place to prevent their re-visiting the grassy parts and disturbing their eggs.

Figures 1, 2, 3, 4, 5 and 6 represent tanks into which the water can be introduced. These are used for stowing and sorting the fish. No. 7 represents the watch-house occupied by the guard and attendants.

The thorough confidence of Prof. Baird in the ultimate success of the experiment of introducing this fish into American waters is shown by his persistent and repeated efforts to import them. The good results have more than realized our expectations, for the growth and weight of the imported fish and the excellence of their offspring have been greater than under the most favorable circumstances in Europe.

The normal weight attained by the carp, in Europe, when *three years* old (the age of maturity), is said to be from *three* to *four* pounds. Those, however, that were imported into this country now weigh from *nine* to *ten* pounds.



PLAN OF BREEDING PONDS FOR CARP AT WASHINGTON, D. C.

The growth of the young fish in both the Druid Hill and Washington Ponds has been very marked, some of them having attained a length of five to seven inches in one summer. This rapidity of growth may be due to the longer period of warm weather in this latitude, and the consequent extension of the feeding season. If this hypothesis be correct, it is probable that a much greater and more rapid growth will be attained in the waters farther south. Many Eastern States have been supplied by the U. S. Commission. We believe this fish is destined to become, at no distant day, of the greatest importance to both the pisciculturist and agriculturist and, therefore, with a view of acquainting our citizens with its history and qualities we make the following extract from a letter of the U. S. Commissioner on the subject:

Hon. James B. Beck.

Sir: * * * * * * *
* * * * * * * *

I have great faith in the future of this new fish, and am quite well satisfied that within ten years it will constitute a very prominent element in the food animals of the country. Although scarcely known in the United States, and but little more as an article of extended application in England and France, it is in Germany and Austria that it is cultivated in the highest degree, so as to constitute a notable article of market supply. The fish itself is probably of Asiatic origin, and has been domesticated in China for thousands of years. It has, however, been so extensively distributed in Europe as to have become, in a measure, a native fish, occurring in public waters as well as in private enclosures. It is emphatically a farmer's fish, and may safely be claimed to be among fishes what chickens are among birds, and pigs and ruminants among mammals. Its special merit lies in the fact of its sluggishness and the ease with which it is kept in very limited enclosures, its being a vegetable feeder and its general inoffensiveness. Whereas trout and black bass require a supply of animal food for their sustenance and growth, the carp, while not disdaining flies, worms, larvæ, etc., lives on the succulent

roots and leaves of aquatic plants, their seeds fallen into the water and other similar substances, and may be fed very readily upon corn, grain, bread, root crops, raw or boiled, and, indeed, any vegetable refuse whatever. Its rate of growth, too, is somewhat marvelous, and as observed so far in the specimens introduced into the United States, being even more remarkable here than in Europe.

Among the original fish imported by us from Europe, and which are now only about three and a half years old, are some from twenty-five to thirty inches in length, weighing from four to eight or nine pounds.

The three varieties imported by us—the scaly, mirror and leathern carp—are all of first class excellence and characterized by broad backs, as distinguished from the sharp back and more bony characters of the common fish. They occupy a conspicuous place in the German fish markets, and bring the same price as the trout, selling generally for about twenty-five cents per pound. The carp will thrive best in artificial or natural ponds with muddy bottoms and abounding vegetation. In large ponds it may not be necessary to add any special food; but in restricted encloures, as, for instance, in those of a fraction of an acre, they may be fed with the refuse of the kitchen, garden, leaves of cabbage, lettuce, leek, etc., hominy or other substances. Grain of any kind is generally better boiled before being fed to the fish; but this is probably not absolutely necessary. It is a prime necessity that there be no predaceous fish embraced in the same pond with the carp. Of course the larger fish will be measurably secure against the attacks of carnivorous species about the same size, but the eggs and young will become a prey to their associates. The carp spawn in the spring, in May and June, and, indeed, under some circumstances, throughout the entire summer. We have young fish spawned all the way from May until September. They are very prolific, the female varying from 5 ,000 to 500,000, according to her size. The eggs adhere tenaciously to whatever they touch; for that reason it is very important that the pond should be provided with floating weeds for such attachment. The eggs hatch out

in a few days and the young grow very rapidly. They feed voraciously upon so-called frog-spittle, the green alga scum that is so common in frog ponds. Consequently such waters are especially adapted for carp. Whenever the water becomes chilled down to perhaps 40°, and especially when frozen over at the top, the fish bury themselves in the mud, aggregating in lots from fifty to one hundred, frequently with their tails projecting and constituting what is called in Germany kettles or rolls. It is very important that they should not be disturbed under such circumstances. Of course while hybenating in this way they are not feeding, although they are said not to lose appreciably in weight. In the more southern regions, where the waters do not freeze, they will probably feed throughout the year and make a more rapid growth. So far, no waters have proved too warm for them. As regards the best plants for a carp pond, I may mention the ordinary pond-weeds *pontederia* and *sagittaria*—splatter docks or pond lilies; and, indeed, any of the kinds that grow in the water with leaves floating upon the surface, duck-weed among the number. Those which produce seeds, like the wild rice, are especially desirable, as the fish feed voraciously upon them.

Very truly yours,

SPENCER F. BAIRD.

Dr. Hessel, superintendent of the ponds at Washington, makes the following statement, which shows how well adapted this fish is to fill a need so long felt by those having waters too warm and limited for the propagation of brook trout and other game fishes:

"'The carp is able,' says Dr. Hessel, 'to live in water where other fishes could not possibly exist—for instance, in the pools of bog-meadows or sloughs.' Though it is not to be inferred from this that the best carp ponds should be thus located.

"In Silesia, puddles two or three feet deep, in the villages, are used for raising two year old carp for stocking distant waters. From this resource a single estate realized what would amount to about fifty-five dollars to the acre of pond

surface. In Europe, carp are always taken to market alive, in tanks or barrels, and, if they are not sold, returned to the water alive at the end of the day. They are said to be kept alive in cellars in the winter, wrapped in wet moss and fed upon bread soaked in milk. Dr. Hessel once kept one this way five weeks. In cold climates they protect themselves from freezing in winter by retiring in groups of fifty to one hundred or more, into cavities in the muddy bottom called 'kettles,' where they pass the time until spring, huddled together in concentric circles, with their heads together, the posterior part of the body raised and held immovable, scarcely lifting the gills for breathing and without taking a particle of food. This abstinence and torpidity lasts in cold countries six or even seven months, and thus they can live out a very rigorous winter.

"In Central Europe its growth is entirely suspended in the winter, the increase in weight taking place from May to August, and especially in July. The rate of growth depends upon many things, the temperature of the water, the quality and quantity of food, the nature of the bottom. In rivers and lakes they attain the greatest size."

In the summer of 1872 the carp was introduced by Mr. Poppe into California from Holstein. As an indication of the value of this fish and what can be accomplished with ordinary care from the stock already distributed, it may be here mentioned that Mr. Poppe succeeded in reaching his ponds in Sonoma county, California, with only five small carp "about the size of a steel pen." These were placed in a pond which had a uniform temperature of about 74° degrees Fahrenheit. Mr. Poppe reports that by May of the following year these fish had increased in length to sixteen inches, and that he secured some three thousand young fish from them. Two of these original fish now survive and are said to be over two feet long and weigh over fifteen pounds a piece. Mr. Poppe has done a very large and thriving business by selling them to stock other ponds. The uniformly warm water which supplies these ponds has no doubt stimulated the growth of the

fish in a great degree, and we cannot, in the colder waters of Maryland, expect such rapid growth and early development; but when it is taken into consideration that to each individual wishing them we have issued twenty fish averaging from three to five inches in length, it should not be many years before the waters of Maryland are well stocked. We are informed that the fish on Mr. Poppe's farm are fed almost wholly on "curd" from the dairy, although this food is sometimes varied by barley, wheat, beans, corn, peas and coagulated blood. Mr. Poppe remarks that "they would eat anything that a hog would." In most of the ponds of Maryland the carp would find a great deal of natural food in the mud, and the aquatic plants would also furnish much food, but where very large numbers are confined in limited waters it will be seen that they can be fed at very small cost. Unfortunately the fish introduced by Mr. Poppe, although the genuine carp, were not of such carefully selected varieties as those brought over by Mr. Hessel, from which the stock in Maryland was derived.

Next spring, before the breeding season, the ponds at Druid Hill Park are to be drawn. Due notice will be given in advance, in order that such of our citizens as desire to propagate this fish may be prepared to receive as many as can be issued.

On the next page will be found a table showing the number of persons and localities reached by the fall and winter distribution.

RECORD OF DISTRIBUTION OF GERMAN CARP *made from November* 1, 1879, *to December* 31, 1879, *by the Maryland Commissioners, under direction of John S. Saunders.*

Date of Transfer.	Obtained from	Place whence taken.	No. of Fish.		Introduction of Fish.			Transfer in charge of, or to whom delivered.
			Orig'nl'y Taken.	Actually Planted.	Place.	Stream.	Tributary of—	
Nov. 1..			20	20	.....	Stony Run.....	.....	J. A. Edmonson.
" 4*.			250	250	Virginia Commission.....	.....	.....	Col. McDonald.
" 8..			20	20	Back River, Md.....	.....	.....	Henry Lange.
" 8†.			16	16	Chapel Cove.....	Miles River.....	Miles River.....	Col. Edward Lloyd.
" 8†.			16	16	Trappe, Talbot county.....	Bartlett's Pond.....	Choptank River..	J. Thos. Bartlett.
" 8†.			16	16	Eureka Mills, Talbot co.....	Eureka Pond.....	Miles River.....	Wm. F. Elben.
" 8†.			16	16	Bartlett's Mill, Talbot co....	Bartlett's Pond.....	Choptank River..	James C. Tarbutton.
" 8†			16	16	Trappe, Talbot county.....	Wright's Pond.....	Choptank River..	Wm. P. Wright.
" 8†.			16	16	Trappe, Talbot county.....	Collins' Pond.....	Choptank River..	Wm Collins.
" 8†.			16	16	Sherwood Mills, Talbot co...	Sherwood Pond....	Skipton Creek....	A. B. Hardcastle.
" 8†.			16	16	Wye Mills, Talbot co..... ..	Wye Pond.....	Wye River.....	J. R. Hopkins.
" 10*.			500	500	.....	.....	.....	C. H. Sherman.
" 10*.			500	500	.....	.....	.....	J. F. Ellis.
" 10..			20	20	Manor Glen, Balto. co.....	Little Gunpowder..	.....	R. Emory, M. D.
" 11..			20	20	Sappington, A A co.....	Pond.	Patuxent River...	J. V. Follansbee.
" 11..			20	20	Cockeysville, Balto. co.....	Pond.....	Gunpowder Falls.	A. T. Lore.
" 12..			20	20	Baltimore, Md	Pond.....	Jones Falls.....	Wm. Shirley.
" 12..	" "	" "	1000	1000	Druid Hill Park	Pond No. 4	.....	.....
" 13..			20	20	Upper ⋈ Roads, Harford co.	Pond.	Little Gunpowder.	Jos. A Hayghe.

* Account of United States Fish Commission. † By Mr. Hughlett.

RECORD OF DISTRIBUTION OF GERMAN CARP *made from November* 1, 1879, *to December* 31, 1879, *by the Maryland Commissioners, under direction of John S. Saunders*—Continued.

Date of Transfer.	Obtained from	Place whence taken.	No. of Fish.		Introduction of Fish.			Transfer in charge of, or to whom delivered.
			Orignl'y Taken.	Actually Planted.	Place.	Stream.	Tributary of—	
Nov. 13.	Carp Pond No. 4, Druid Hill P.	Druid Hill Park.	20	20	Hunting Hill, Montgom'y co	Pond		E. L. Trichbeleby.
" 13.	"	"	20	20	Davidsonville, A. A. co	Pond	Patapsco River	Thos. S. Iglehart.
" 13.	"	"	20	20	Davidsonville, A. A. co	Pond	South River	Jas. A. Iglehart.
" 13*	"	"	50	50	Jobstown, N. J.			P. Lorillard.
" 13*	"	"	30	30	Wenonah, N. J.			Milton S. Price.
" 14.	"	"	20	20	Ellicott City, Md.	Pond	Patapsco River	Marcus W. Brown.
" 15.	"	"	20	20	Govanstown, Md.	Pond	Lake Roland	J. Wilson Brown.
" 15.	"	"	20	20	Rider's Station, Balto. co.	Pond	Lake Roland	Isaac Hartman.
" 15.	"	"	20	20	Parkton, Baltimore co.	Pond	Little Gunpowder	S. V. Trump.
" 17.	"	"	20	20	Upper ✕ Roads, Harford co.	Pond	Little Gunpowder	James D Ball.
" 18.	"	"	20	20		Pond	Patapsco River	O. Lugger.
" 19.	"	"	20	20	Westminster, Md.	Pond	Monocacy River	W. A. Cunningham.
" 19.	"	"	20	20	Westminster, Md.	Pond	Monocacy River	Granv. Coppersmith
" 19.	"	"	20	20	Taitsburg, Montgomery co.	Pond	Potomac River	W. A. Cocke.
" 19.	"	"	20	20	Upper ✕ Roads, Harford co	Pond	Big Gunpowder	W. A. Spencer.
" 19†	"	"	80	80	Reedburn, Queen Anne co.	Pond	Chester River	Richard Hollyday.
" 19†	"	"	20	20	Uryville, Kent co.	Pond	Chester River	Wm. W. McKenett.
" 21.	"	"	20	20	Hereford, Baltimore co.	Pond	Gunpowder	T. G. Mitchell.
" 21	"	"	20	20	Davidsonville, A. A. co.	Pond	South River	Samuel Anderson.

* Account of United States Fish Commission. † By Mr. Hughlett.

RECORD OF DISTRIBUTION OF GERMAN CARP *made from November* 1, 1879, *to December* 31, 1879, *by the Maryland Commissioners, under direction of John S. Saunders*—Continued.

Date of Transfer.	Obtained from	Place whence taken.	No. of Fish.		Introduction of Fish.			Transfer in charge of, or to whom delivered.
			Orig'l'y Taken.	Actually Planted.	Place.	Stream.	Tributary of—	
Nov. 22*	Hatching House.	Druid Hill Park.	40	40	Cambridge, Md	Pond	Chicamacomico R	Geo. J. Meekins.
" 22*	"	"	20	20	Greensborough, Caroline co	Pond	Choptank River	W. H. Comegys
" 22*	"	"	20	20	Greensborough, Caroline co.	Pond	Choptank River	Richard H. Comegys
" 22*	"	"	20	20	Greensborough, Caroline co.	Pond	Choptank River	H. C. Comegys.
" 22*	"	"	20	20	Cambridge, Md	Pond	Chicamacomico R.	Wm. H. Hayward.
" 22*	"	"	86	86	Huntington, Caroline co	Pond	Choptank River	Danl. J Waldron.
" 22*	"	"	86	86	Easton, Talbot co	Pond	Miles River	Thomas Hughlett.
" 22.	"	"	20	20	Westminster, Md	Pond	Patapsco River	H. S. Mottle.
" 22.	"	"	20	20	Carrolton, Md	Pond	Patapsco River	H S. Weaver.
" 24.	"	"	50	50	Fair View, Prince George co.	Pond		Oden Bowie.
" 24.	"	"	20	20	Luthervilie, Md	Pond	Gunpowder	George M. Horn.
" 26.	"	"	20	20	Fork Meeting, Baltimore co.	Pond	Big Gunpowder	Chas J. Riddle.
" 27	"	"	20	20	Pikesville, Md	Pond	Gwynns Falls	Thos. J. Meyer.
" 27.	"	"	30	30	Green Spring, Baltimore co	Pond		Saml. Shoemaker.
" 28.	"	"	20	20	Paper Mills, Baltimore co	Pond	Gunpowder	Wm. H. Hoffman.
Dec'r 4*	"	"	70	70	Johnson's ✕ Rds, Dorchester	Pond	Nanticoke River	John N. Wright.
" 4*	"	"	20	20	Cambridge, Md	Pond	Transquaking Riv	George J. Meekins.
" 5.	"	"	20	20	Towsontown, Md	Pond	Jones Falls	C. B. Slingluff.
" 4†	"	"	580	580	....	....	....	J. F. Ellis.

* By Mr. Hughlett. † On account of United States Fish Commission.

RECORD OF DISTRIBUTION OF GERMAN CARP *made from November* 1, 1879, *to December* 31, 1879, *by the Maryland Commissioners, under direction of John S. Saunders*—Continued.

Date of Transfer.	Obtained from	Place whence taken.	No. of Fish.		Introduction of Fish.			Transfer in charge of, or to whom delivered.
			Orignl'y Taken.	Actually Planted.	Place.	Stream.	Tributary of—	
Dec'r 6.	Hatching House.	Druid Hill Park.	20	20	Woodsburg, Md.	Pond	Monocacy	Henry Hupman.
" 6.	"	"	20	20	Liberty Town, Md	Pond	Monocacy	John F. Eyler.
" 8*	"	"	375	375				H. B. Nicolas.
" 8†	"	"	500	500				Wm. Hamlen.
" 10.	"	"	20	20	Pleasantville, Md.	Pond	Little Gunpowder.	Samuel G. Scarff.
" 10.	"	"	20	20	Pleasantville, Md.	Pond	Little Gunpowder.	Chas. T. Scarff.
" 11.	"	"	20	20	New Market, Md.	Pond	Monocacy	Eliza S. Wormley.
" 11.	"	"	20	20	Catonsville	Pond	Gwynns Falls	John W. Long.
" 11.	"	"	20	20	Silver Run, Md.	Pond	Monocacy	Mathias I. Bogan.
" 11.	"	"	20	20	Silver Run, Md	Pond	Monocacy	John W. Rittase.
" 12.	"	"	20	20	Baltimore county	Pond	Gwynns Falls	A. E. Groff.
" 12.	"	"	20	20	Baltimore county	Pond	Gunpowder	J. R. Mordecai
" 13.	"	"	20	20	Baltimore county	Pond	Gunpowder	McDonogh School.
" 13	"	"	20	20	Sulphur Spring, Md.	Pond	Patapsco	Henry Cragg.
" 16‡	"	"	20	20	Easton, Talbot county	Pond		Dr. B. C. Cherbonnier
" 16‡	"	"	20	20	Centreville, Queen Anne co.	Pond		Saml. T. Earle.
" 16‡	"	"	20	20	Greensborough, Caroline co.	Pond		D. J. Zacharias.
" 16‡	"	"	40	40	Milford, Del.			Hon. J. W. Causey.
" 18.	"	"	20	20	Govanstown	Pond	Jones Falls	M. H. Leinkle.

* On account of Virginia Commission. † On account of United States Fish Commission. ‡ By Mr. Hughlett.

RECORD OF DISTRIBUTION OF GERMAM CARP *made from November* 1, 1879, *to December* 31, 1879, *by the Maryland Commissioners, under direction of John S. Saunders*—Continued.

Date of Transfer.	Obtained from	Place whence taken.	No. of Fish.		Introduction of Fish.			Transfer in charge of, or to whom delivered.
			Orignl'y Taken	Actually Planted.	Place.	Stream.	Tributary of—	
Dec. 20	Hatch'g House	Druid Hill Park	600	600	.....	.....	.....	J. F. Ellis.
" 23.			20	20	Walkersville, Md.....	Pond	Monocacy.....	W. N. Todd.
" 23			20	20	Walkersville, Md.....	Pond.....	Monocacy.....	W. C. Neidig.
" 29			20	20	.....	.....	.....	Chas. Walker.
" 30.			20	20	.....	.....	.....	C. Schaeffer.
" 30			20	20	.....	.....	.....	Tho. Engler.
" 30.			20	20	.....	.....	.....	S. Ross.
			6135	6135				

* On account of United States Fish Commission.

Oyster—(*Ostrea virginiana*).

We have hitherto paid no special attention to one great source of wealth in the State, one of the most important products of our waters, as there exists a department specially charged with the protection of the oysters. But the study of the fishes inhabiting the Chesapeake Bay has necessarily led us to the consideration of the condition of the oyster-beds. As some of our most important fishes derive their food either directly from the oyster, or prey upon smaller fishes which are attracted to the oyster-beds by the parasites which there abound, the occurrence of several varieties in our waters is dependent upon the existence of the oyster-beds.

These considerations have rendered it necessary, for a just appreciation of the subject, that we should make a study of the natural history of this important mollusk. With this object in view, we were fortunate in securing the aid of Dr. W. K. Brooks, associate in Biology of the Johns Hopkins University, and the trustees of the Institution very kindly sanctioned Dr. Brooks' absence for a few weeks prior to the close of the session. Having urged upon Dr. Brooks the importance of commencing his researches early in the spring, he accordingly proceeded to Crisfield in the month of May.

The study of the embryology of the oyster resulted in the acquisition of information which must prove most valuable not only to the inhabitants of the Chesapeake Bay, but to the whole Atlantic Coast. The results of these investigations by Dr. Brooks, and his very able treatise on the embryology of the oyster, will be found in the appendix of this report. It will be seen that these investigations have placed it within our power to multiply the oyster to an indefinite amount, and although the supply has diminished to a very alarming extent, we have now sufficient knowledge to enable us, at any time, to arrest this decrease. A careful examination of the results of Dr. Brooks' researches would indicate the advisability of establishing at some suitable point on the Chesapeake Bay, without delay, a breeding park. This can be done at very little expense, and would be of much importance not only to

enable us to trace the further development of the oyster, but would, no doubt, be of great benefit as a model on which establishments of a similar kind can be constructed.

If the artificial propagation of the oyster prove a success practically, and if the art of manipulating them can be easily acquired, as Dr. Brooks' descriptions would indicate, an almost indefinite supply of young oysters could be derived in this manner, and they could be easily transferred to localities suitable for their final development. Much of the present drain, on the natural beds, for transplanting would become unnecessary, and the supply for cultivation in shoal waters could be derived by this simple artificial propagation. The planted beds could then be furnished at much less expense to the cultivator.

By pursuing this method, the beds would not only be relieved of the necessity for disturbing them during the periods when they should be at rest, but a strong inducement to violate the protective laws would be removed. We feel satisfied that the able Board, under whose special care the oysters are placed, will suggest most proper and efficient means for their protection. We simply place within their reach the results of recent investigations which have been conducted in connection with our study of the waters of the State, and we trust that they will be found to contain something of value. The oyster, as we have already said, must have a very important bearing on the fish yield of our waters, and for this reason is ever a matter of interest to us.

It is well known that quite a large population on the seacoast of France derive their chief support from the cultivation of the oyster, and many of the marine departments owe their prosperity mainly to this industry. The Europeans have, however, confined themselves to collecting, carefully protecting and caring for the oyster after it has reached that stage when it attaches itself to some stationary object. Dr. Brooks has pointed out to us how we can go far beyond the oyster culturists of Europe in being able to artificially impregnate the eggs as in fish culture, and in this way, to a great extent, control the increase.

In the oyster parks of France the success in collecting the spat is dependent oftentimes on the conditions of the water and the season. If the collectors are placed in position too long before the spatting season, they are covered with sediment and lose their capacity for receiving the spat. Again, they are frequently placed in position after the spatting season has advanced, and the yield is consequently much diminished. It will be seen that by artificial impregnation these causes of loss can, to a great extent, be guarded against.

The locality of Crisfield was selected by us after consultation with the Superintendent of the U. S. Coast and Geodetic Survey, as we ascertained that it was proposed to continue, during the summer, the hydrographic investigation which had been commenced in Tangier Sound the previous year. We hoped to be able to combine the results of the investigations of the physical conditions surrounding the oyster-beds with the lessons deduced from the biological investigations, thereby making the work more complete and our conclusions more trusty. The hydrographic investigations were conducted by Master Francis Winslow in the Coast Survey schooner "Palinurus." Through the courtesy of Mr. Carlisle Patterson, Superintendent of the Coast and Geodetic Survey, we have made extracts from the reports of his researches in this locality during the two seasons. These extracts will be found in the appendix.

Early in June, Dr. Brooks was joined by a number of scientific workers connected with the Johns Hopkins and other Universities. For the accommodation of these additional investigators, I secured from the U. S. Commissioner the barges which were used in the shad-hatching operations, and which furnished them with comfortable quarters and quite a commodious laboratory. The small boats of the Fish Commission and a steam launch, which was a part of the shad-hatching equipment, also provided the means of doing a good deal of inshore dredging and surface collecting. The steamer "Lookout," which had been provided with dredging apparatus, was used for dredging in the Sound and Bay and furnished material for study.

We would call your attention to the extracts given from the report of Mr. Winslow, as his investigations clearly show that there has been a very decided decrease of the oysters in the best beds; in fact, that some of them have practically been exhausted. His examinations indicate the necessity of our providing without delay the means of arresting this exhaustion. Although it was impracticable to determine the exact conditions of the beds and the actual amount of the oysters of each class that are to be found, without much more extended investigations than the Coast Survey has yet made, the *relative* conditions of the beds have been pretty well ascertained. It is earnestly hoped that this department will continue the valuable investigations they have commenced, and that we will be able to profit by the cumulative work in this direction.

A careful review of oyster culture in France, the results of the researches of Dr. Brooks, the investigations by the Coast Survey of the beds of Tangier and Pocomoke Sounds, the study of the oyster trade of Maryland and the operations of our oyster police force, causes us to suggest that perhaps the most rational solution that can be arrived at would be the division of the beds of the Chesapeake Bay into sections, and protecting alternately the beds in each section. The period in which the embryo oyster remains unattached, and the distance that the young oysters are carried from the parents during their early life is so great, that the abundance of spat deposited at a given point may not be the result of the fertility of the adults on an adjacent bed. By protecting a bed thoroughly, sufficient spat may be produced from it to provide the surrounding localities, and probably those quite remote.

Conclusion.

We have compiled from the several tables showing the result of the hatching operation during the six years of the existence of the Maryland Fish Commission the following summary, showing the total number of each variety of fish which we have hatched and deposited in the waters of the State:

NAME OF FISH.	1874.	1875.	1876.	1877.	1878.	1879.	TOTAL.
California Salmon.....	144,000	91,500	1,088,301	150,500	710,600	312,236	2,497,140
Shad.....		4,150,000	2,721,000	7,419,500	8,285,600	4,757,000	27,333,100
Land Locked Salmon..			22,600		40,781	26,500	89,881
Smelt.....			3,475	400,000			403,475
Brook Trout				50,480	234,500	47,000	331,980
German Carp.....						6,135	6,135
Totals	144,000	4,241,500	3,838,376	8,020,480	9,270,881	5,148,871	33,663,911

It will be seen that 33,663,911 fish have been added by artificial means to the waters of the State. Of course many of these have been planted as a matter of experiment and nothing more may ever be heard of them, but each of the varieties experimented with is of such importance that the possibility of a success would warrant the small amount expended on these experiments. The main efforts of the commission have been directed towards the propagation of the salmon, shad and German carp. Of the last two, we are absolutely certain of the great benefits which will be derived. By referring to the only three statements which we have given, those showing the number of shad recorded, as taken in the seines operated at the head of the Bay, as shipped from Havre de Grace, and as inspected in Washington, it will be seen that the increase of shad alone at these points, in the year 1879 over the year previous, amounts to 285,874. It is reasonable to infer that the same increase has taken place in other localities; but did this show the whole increase, and if we value the shad at ten cents each, the increase would represent the sum of $28,587.40, almost three times the annual appropriation for fish culture by the State. This would indicate that our citizens are already deriving adequate results, even if the labors of the commission were limited to the propagation of shad alone. As we have before mentioned, shad ascend the rivers only after they have become adult and are ready to spawn. Therefore the increase of fish in any one year, until a sufficient time has elapsed for the second generation from those hatched artificially, to return, is to be credited to one year's operations only, as the increase of the shad in 79 is most likely attributable solely to the return of those propagated in 76. The work of the succeeding

year 77 and 78 has not influenced at all this increase. The results of the return of the fish hatched during these years will be felt only in subsequent years.

In fulfilling the duties imposed upon us by the act under which the Fish Commission was organized, we cannot do more than call attention to the recommendations for protection which have been made in our previous reports.

The necessity for the construction of a fish-way to enable the migratory fish to ascend the river beyond the Great Falls of the Potomac becomes more urgent each year. For several years we have placed a sufficient number of shad in the upper waters of this river to insure their returning in sufficient numbers to make their presence felt, if proper means are provided for them to overcome this barrier to their ascent. No doubt those fish that have gone down to the sea over the falls will on their return make every effort to ascend them. Great as is the importance of a fish-way at this point to the inhabitants above the falls, it is of almost equal importance to those living below, as it would extend the spawning grounds to a very great extent and insure a future supply to the important fisheries of this river.

The need for efficient protective laws on the Potomac is greatly felt, and we would earnestly urge upon the assemblies of both Virginia and Maryland to pass similar laws protecting the river and giving the officers of the law concurrent jurisdiction.

We take pleasure in repeating our acknowledgments to the several transportation lines for continued courtesies.

Respectfully submitted,

T. B. FERGUSON,
THOS. HUGHLETT,
Commissioners.

APPENDIX.

DEVELOPMENT

OF THE

AMERICAN OYSTER.

BY

DR. W. K. BROOKS.

Development of the American Oyster,

(*Ostrea virginiana List.*)

By W. K. BROOKS,

Associate in Biology, Johns Hopkins University,

BALTIMORE, MD.

At the request of Major Ferguson, Fish Commissioner of Maryland, that I should attempt to trace the development of the young oyster, I made arrangements which enabled me to leave Baltimore a month before the close of my year's work at the University, and the opening of the Seaside Laboratory, Dr. Martin and Dr. Sihler generously taking charge of my classes, and affording me an entire month for uninterrupted work upon the oyster. The United States Coast Survey having determined to continue the examination of the oyster beds of Pokamoke and Tangier Sounds, Major Ferguson was desirous of having the biological investigations commenced in the same locality I therefore arranged to open the Seaside Laboratory of the Johns Hopkins University in June, 1879, at Crisfield, within reach of the great natural oyster beds of Tangier and Pokamoke Sounds.

While I regard the information which I was able to obtain upon certain purely scientific questions in embryology as the most important and valuable result of my summer's work, I am aware that most of the persons who are interested in the habits of the oyster and in oyster culture would not care to read a purely technical embryological paper. It seems best, then, to divide my account into two parts, and to give first a somewhat popular description of the method of artificial fertilization, with a description of a sufficient number of my figures to convey a general idea of the manner of develop-

ment, and then to complete the paper in a second part, devoted to a minute description of the figures, a discussion of the theoretical and comparative bearings of my observations and a notice of the observations and views of others.

The place which was selected was excellently fitted for the work. The town of Crisfield, Md., is situated at the junction of Tangier and Pokomoke Sounds, two large and wide but shallow sheets of water, whose muddy bottoms abound in oysters of the best quality. The town is one of the most important centres of the oyster-packing industry, and is built in the water upon the shells of the oysters, which have been shipped to all parts of the country for consumption. As fast as the oysters are opened the shells are used to build up new land, and with them a large peninsula has been formed, stretching out for more than half a mile from the low marshy shore towards the oyster beds, and furnishing room for wide streets, a railroad and a steamboat landing, in addition to the large packing houses and the shops and dwellings for a population of several thousand people. A single view of the long, white, solid streets and docks of this singular town would convey a much more vivid idea of the oyster-packing industry than any number of tables of statistics.

I found everybody greatly interested in all that relates to the oyster, and ready to give me every help in my work, but I am especially indebted to Dr. H. H. Gunby, Mr. T. S. Hodson and Mr. J. J. Lawson for many kindly favors, which not only enabled me to work to the greatest advantage, but also rendered my stay among them very pleasant.

BREEDING HABITS OF THE AMERICAN OYSTER.

Our knowledge of the development of the oyster is derived from the fragmentary observations of various German, French, English and Russian embryologists, whose work will be noticed at length further on. While the subject has received the attention of a number of observers, no one has been able to get anything like a complete series of the early stages of development, and I approached my work without hope of ac-

complishing much of purely scientific value, although I did expect to obtain some information as to the time and conditions of spawning, and other questions of economic interest. My uncertainty of success was increased by the total failure of an attempt which I had made the summer before.

All the published papers upon the subject state that the eggs are fertilized inside the body of the parent, and that the young are carried inside the parent shell until they are quite well advanced in development, and provided with shells of their own; that they swim about after they are discharged from the parent until they find a place to attach themselves, but that they undergo no change of structure between the time when they leave the parent and the time when they become fixed. Misled by these statements, which are not true with our species, I opened numbers of oysters during the summer of 1878, and carefully examined the contents of the gills and mantle chambers, but found no young oysters. I concluded that the time during which the young are carried by the parent must be so short that I had missed it, and I entered upon the work this season with the determination to examine adult oysters every day, through the breeding season, in search of young, and at the same time to try to raise the young for myself by artificially fertilizing the eggs after I had removed them from the body of the parent.

I met with complete success with the second method from the beginning, and succeeded in raising countless millions of young oysters, and in tracing them through all their stages of development until they had acquired all the characteristics which the European embryologists have described and figured in the young of the European oyster at the time it leaves its parent to become fixed for life.

I reached Crisfield on the 19th of May, and established myself about three miles from the town and about half a mile from Pokamoke Sound, and on Monday, the 21st, I opened a dozen fresh oysters, and found three females with their ovaries filled with ripe ova, and one male with ripe spermatoza.

I mixed the contents of the reproductive organs of these four oysters, and within two hours after the commencement

of my first experiment, I learned by the microscope that the attempt at artificial fertilization was successful, and that nearly all of my eggs had started on their long path towards the adult form.

I made careful microscopic examination of the gills and mantles of all these oysters, but neither at this time nor afterwards did I find any fertilized eggs or young inside the parent shell, although I examined more than a thousand adults during the season. During the summer I found females with the ovaries so distended with ripe eggs that they were oozing from the openings of the oviducts; others where the ovaries were half emptied, and others which had discharged almost all their eggs, and others at all the intermediate stages, but in no case did I find a single developing egg inside the shell of the parent.

I have accumulated enough evidence to show beyond the possibility of doubt, that so far as the oysters of the Chesapeake Bay, during the summer of 1879, are concerned, the eggs are fertilized outside the body of the parent, and that, during the period which the young European oyster passes inside the mantle cavity of its parent, the young of our oyster swims at large in the open ocean.

While this evidence cannot be regarded as sufficient to show that the young of the American oyster are never carried by their parents, it is certainly enough to show that this cannot be assumed from the analogy of the European oyster. Most of the popular treatises on the use of the microscope state that during the summer young oysters may be found inside the shells of the old ones, and as the number of amateur workers with the microscope in this country is quite large, I should be glad to learn whether any one has ever found this to be the case with American oysters.

Until some such evidence is produced it is fair to conclude that my results are to be applied to all the American oysters, and that there is a very important difference between them and the European species.

ANATOMICAL OUTLINE SKETCH.

The thorough study of the anatomy of the adult oyster is rather difficult, but there is no difficulty in gaining all the knowledge which is needed for procuring and fertilizing the eggs. As I hope that a way will be found to turn my observations to practical account in oyster culture, I will give a very brief sketch of the structure of the oyster—such a sketch as will enable any one who reads it with an opened oyster before him to acquire the necessary anatomical knowledge. It is hardly possible to write such a description without using a few technical terms, such as anterior and posterior, dorsal and ventral. As the end of the body where the mouth is placed is not marked by a head, it must be spoken of as the *anterior end*, not as the *head*, and the opposite end as the *posterior*. As the oyster lies on one side, the *top* and *bottom* of its body do not correspond to the regions which occupy these positions in an upright mussel or clam, and it is most convenient to speak of that part of the oyster's body which answers to the upper surface of a clam as dorsal and the opposite as ventral.

The general structure of an oyster may be roughly represented by a long narrow memorandum book, with the back at one of the narrow ends instead of at one of the long ones. The covers of such a book represent the two shells of the oyster and the back represents the hinge, or the area where the two valves of the shell are fastened together by the hinge ligament. This ligament is an elastic, dark brown structure, which is placed in such a relation to the valves of the shell that it tends to throw their free ends a little apart. In order to understand its manner of working, open the memorandum book and place between its leaves, close to the back, a small piece of rubber to represent the ligament. If the free ends or the cover are pulled together the rubber will be compressed and will throw the covers apart as soon as they are loosened. The ligament of the oyster-shell tends by its elasticity to keep the shell open at all times, and while the oyster is lying un-

disturbed upon the bottom, or when its muscle is cut, or when the animal is dying or dead, the edges of the shell are separated a little.

The shell is lined by a thin membrane, the mantle, which folds down on each side, and may be compared to the leaf next the cover on each side of the book. The next two leaves of each side roughly represent the four gills, the so-called "beard" of the oyster, which hang down like leaves into the space inside the two lobes of the mantle. The remaining leaves may be compared to the body or *visceral mass* of the oyster.

Although the oyster lies upon the bottom with one shell above and one below, the shells are not upon the top and bottom of the body, but upon the right and the left sides. The two shells are symmetrical in the young oyster, but after it becomes attached the lower or attached side grows faster than the other, and becomes deep and spoon-shaped, while the free valve remains nearly flat. In nearly every case, the lower or deep valve is the left. As the hinge marks the anterior end of the body, an oyster which is held on edge with the hinge away from the observer and the flat valve on the right side, will be placed with its dorsal surface uppermost, its ventral surface below, its anterior end away from the observer, and its posterior end towards him, and its right and left sides on his right and left hands respectively.

In order to examine the soft parts, the oyster should be opened by gently working a thin flat knife blade under the posterior end of the right valve of the shell, and pushing the blade forwards until it strikes and cuts the strong adductor muscle, which passes from one shell to another and pulls them together. As soon as this muscle is cut the valves separate a little, and the right valve may be raised up and broken off from the left, thus exposing the right side of the body. The surface of the body is covered by the mantle, a thin membrane which is attached to the body over a great part of its surface, but hangs free like a curtain around nearly the whole circumference. By raising its edge, or gently tearing the whole right half away from the body, the gills will be exposed.

These are four parallel plates which occupy the ventral half of the mantle cavity and extend from the posterior nearly to the anterior end of the body. Their ventral edges are free, but their dorsal edges are united to each other, to the mantle and to the body. The space above or dorsal to the posterior ends of gills, is occupied by the oval, firm, adductor muscle, the so-called "heart." For some time I was at a loss to know how the muscle came to be called the heart, but a friend told me that he had always supposed that this was the heart, since the oyster dies when it is injured. The supposed "death" is simply the opening of the shell when the animal looses the power to keep it shut. Between this muscle and the hinge the space above the gills is occupied by the body, or *visceral mass*, which is made up mainly of the light colored reproductive organs and the dark colored digestive organs, packed together in one continuous mass.

If the oyster has been opened very carefully, a transparent crescent-shaped space will be seen between the muscle and the visceral mass. This space is the pericardium, and if the delicate membrane which forms its sides be carefully cut away the heart may be found without any difficulty, lying in this cavity, and pulsating slowly. If the oyster has been opened roughly, or if it has been out of water for some time, the rate of beating may be as low as one a minute, or even less, so the heart must be watched attentively for some time in order to see one of the contractions.

The heart is made up of two chambers, a loose spongy transparent *auricle*, which occupies the lower part of the pericardium, and receives blood from the gills through transparent blood vessels, which may usually be seen without difficulty running from the gills towards the heart, and a more compact white *ventricle*, which drives the blood out of the pericardium through transparent arteries, which are usually quite conspicuous.

The visceral mass is prolonged backwards over the pericardium and the adductor muscles, and here contains the rectum surrounded by prolongations of the white reproductive or-

gans. Still farther back, on the middle of the posterior face of the adductor muscle, is the anus, a long vertical slit, opening into the space between the lobes of the mantle and above the posterior ends of the gills.

In front of the gills, that is between them and the hinge, there are four fleshy flaps—the lips—two on each side of the body. They are much like the gills in appearance, and they are connected with each other by two ridges which run across the middle of the body close to the anterior end, and between these folds is the large oval mouth, which is thus seen to be situated, not at the open end of the shell, but as far away from it as possible. As the oyster is immovably fixed upon the bottom, and has no arms or other structures for seizing food and carrying it to the mouth, the question how it obtains its food at once suggests itself. If a fragment of one of the gills is examined with a microscope, it will be found to be covered with very small hairs, or *cilia*, arranged in rows. Each of these cilia is constantly swinging back and forth, with a motion something like that of an oar in rowing. The motion is quick and strong in one direction and slower in the other. As all the cilia of a row swing together, they act like a line of oars, only they are fastened to the gill, and as this is immovable, they do not move forwards through the water, but produce a current of water in the opposite direction. This action is not directed by the animal, for it can be observed for hours in a fragment cut out of the gill, and if such a fragment be supplied with fresh sea water, the motion will continue until it begins to decay. While the oyster lies undisturbed on the bottom, with its muscle relaxed and its shell open, the sea water is drawn on to the gills by the action of the cilia, for although each cilium is too small to be seen without a microscope, they cover the gills in such great numbers that their united action produces quite a vigorous stream of water, which is drawn through the shell and is then forced through very small openings on the surfaces of the gills into the *water tubes*, inside the gills, and through these tubes into the mantle cavity, and so out of the

shell again. As the stream of water passes through the gills the blood is aerated by contact with it. The food of the oyster consists entirely of minute animal and vegetable organisms and small particles of organized matter. Ordinary sea water contains an abundance of this sort of food, which is drawn into the gills with the water, but as the water strains through the pores into the water tubes, the food particles are caught on the surface of the gills by a layer of adhesive slime which covers all the soft parts of the body. As soon as they are entangled the cilia strike against them in such a way as to roll or slide them along the gills towards the mouth. When they reach the anterior ends of the gills they are pushed off and fall between the lips, and these again are covered with cilia, which carry the particles forwards until they slide into the mouth, which is always wide open and ciliated, so as to draw the food through the œsophagus into the stomach. Whenever the shell is open these cilia are in action, and as long as the oyster is breathing a current of food is sliding into its mouth.

The cilia and particles of food are too small to be seen without a microscope, but if finely powdered carmine be sprinkled over the gills of a fresh oyster, which has been carefully opened and placed in a shallow dish of sea water, careful observation will show that as soon as the colored particles touch the gills they begin to slide along with a motion which is quite uniform, but not much faster than that of the minute hand of a watch.

This slow, steady, gliding motion, without any visible cause, is a very striking sight, and with a little care the particles may be followed up to and into the mouth.

In order to trace the course of the digestive organs, the visceral mass may be split with a sharp knife or razor. If the split is pretty near the middle of the body, each half will show sections of the short, folded œsophagus, running upwards from the mouth, and the irregular stomach, with thick semi-transparent walls, surrounded by the compact, dark

greenish liver. Back of the liver and stomach the convoluted intestine will be seen, cut irregularly at several points by the section.

The coils of the intestine are imbedded in a light-colored mass of tissue—the reproductive organ—which forms the greater part of the visceral mass. The reproductive organ varies greatly according to the season, and forms most of what is known as the "fat" of the oyster.

There are no accessory organs of reproduction, and the position, form and general appearance of the reproductive organ is the same in both sexes. There is no characteristic by which a male oyster can be distinguished from a female without microscopic examination. As the reproductive organ has an opening on each side of the body, it is usually spoken of as double, but in the adult oyster it forms one continuous mass, with no trace of a division into halves, and extends entirely across the body and into all the bends and folds of the digestive tract.

As my observations only extend over one summer, I cannot make any general statements as to the breeding season, except that the oysters in shallow water spawn first, and those in deeper water later, as the water becomes warmer. Nearly all the oysters in shallow water spawn at about the same time, but there is more difference in the oysters taken from the same bed in deep water. Oysters in from one to six feet of water in the vicinity of Crisfield, probably spawn between the middle and end of May, but oysters with ripe eggs were found in water from five to six fathoms deep from the 1st to the 30th of July, although most of them spawn late in June.

ARTIFICIAL IMPREGNATION OF THE OYSTER EGGS.

If a number of oysters are opened during the breeding season, a few will be found with the reproductive organ greatly distended and of an uniform pure opaque white color. These are oysters which are spawning or nearly ready to spawn.

If the point of a knife be pushed into the reproductive organ a milk-like fluid will ooze out of the cut, and a little of it may be taken up on a knife blade and transferred to a glass slide for examination. The drop of fluid should be thoroughly mixed with a drop of sea water and placed on the slide, and gently covered with a cover-glass, and examined with a magnifying power of about one hundred diameters. If the specimen is a female, this power will show that the white fluid is almost entirely made up of irregular pear-shaped ovarian eggs (Figure 49), each of which contains a large circular transparent germinative vesicle surrounded by a layer of granular slightly opaque yolk. It is almost impossible to describe the slight differences which distinguish the perfectly ripe egg from those which are nearly ripe but not capable of fertilization, although a very little experience will enable one to tell whether it is worth while to attempt the fertilization of the eggs of any given female.

When the drop of fluid is thoroughly mixed with the sea water, the eggs should appear clean, sharply defined, separate from each other, and pretty uniformly distributed through the drop, as shown in the figure. If they adhere to each other, or if their outlines are indistinct, or if there is much fine granular matter scattered between the eggs, it is probable that the attempt at artificial fertilization will at best be only partially successful.

When a perfectly ripe female is found, it should be set aside and the search continued for a male. The question of the sex of the oyster has long been a matter of dispute, and the subject will be fully discussed in another place. All that concerns us now is to know that for all practical purposes the sexes are separate in the European as well as the American oyster. At the breeding season each individual is either exclusively a male or exclusively a female. Out of several thousand which I examined, I have not found one which contained both eggs and male cells, and all the best authorities upon the European oyster make the same statement, although there is some reason for the belief that an oyster may give

rise to eggs one season and to male cells another year. When a drop of the milky fluid from a ripe male is mixed with a little sea water and examined with a magnifying power of one hundred diameters, it is seen at a glance to be quite different from the fluid of a female. There are no large bodies like the eggs, but the fluid is filled with innumerable numbers of minute granules (Figure 48), which are so small that they are barely visible when magnified one hundred diameters. They are not uniformly distributed, but are much more numerous at some points than at others, and for this reason the fluid has a cloudy or curdled appearance. By selecting a place where the granules are few and pretty well scattered, very careful watching will show that each of them has a lively dancing motion, and examination with a power of five hundred diameters will show that each of them is tadpoll-shaped (Figure 50), and consists of a small, oval, sharply defined "head" and a long, delicate "tail," by the lashing of which the dancing is produced.

It is more difficult to decide whether the male cells are perfectly ripe than it is to decide in the case of the eggs. With a magnifying power of five hundred diameters, each "head" should have a clear, well-marked outline, and they should be very uniform in size, and separated from each other, as in Figure 50. Under very favorable circumstances this power should also show the "tails," as very faint undulating lines.

If the "heads" vary much in size, or if they are aggregated into bunches, with the "tails" radiating from the bunches in all directions, or if there is much granular matter so small that the outlines of the particles are not visible when magnified five hundred diameters, the fluid is not perfectly ripe, and fertilization with it will not in all probability be very successful.

NUMBER OF EGGS.

As the male cells are infinitely more numerous than the eggs, the ripe fluid from even one small male is enough to fertilize all the eggs of five or six large females.

The number of male cells which a single male will yield is great beyond all power of expression, but the number of eggs which an average female will furnish may be estimated with sufficient exactness. A single ripe egg measures about one five hundredth of an inch in diameter, or five hundred laid in a row, touching each other, would make one inch; and a square inch would contain five hundred such rows, or 500 x 500 = 250,000 eggs. Nearly all the eggs of a perfectly ripe female may be washed out of the ovary into a beaker of sea water, and as they are heavier than the sea water, they soon sink to the bottom, and the eggs of a medium sized female will cover the bottom of a beaker two inches in diameter with a layer of eggs one-twentieth of an inch deep. The area of the bottom of a beaker two inches in diameter is a little more than three square inches, and a layer of eggs one-twentieth of an inch deep, covering three square inches, is equal to one three-twentieths of an inch deep and two square, and as a single layer of eggs is one-five-hundredth of an inch thick, a layer three-twentieths of an inch thick will contain seventy-five layers of eggs, with 250,000 eggs in each layer, or 18,750,000 eggs. It is difficult to get the eggs perfectly pure, and if we allow one-half for foreign matter and errors of measurement, and for imperfect contact between the eggs, we shall have more than nine millions as the number of eggs laid by an oyster of average size, a number which is probably less than the true number.

Möbius estimates the number of eggs laid by an average European oyster at 1,012,925, or only one-ninth the number laid by an ordinary American oyster, but the American oyster is very much larger than the European, while its eggs are less than one-third as large, so the want of agreement between these estimates does not indicate that either of them is incorrect.* Another estimate of the number of eggs

*Möbius' measurement, from .15 to .18 millimeters, is given (Austern und Austern-wirtschaft, 1877), as the diameter, not of the egg, but of the embryo, but his figures show that the European oyster, like the American, does not grow much during the early stages of development, but remains of about the same size as the egg.

laid by the European oyster is given by Eyton, (History of the Oyster and Oyster Fisheries, by T. C. Eyton. London: 1858). He says, p. 24, that there are about 1,800,000, and therefore agrees pretty closely with Möbious.

An unusually large American oyster will yield nearly a cubic inch of eggs, and if these were all in absolute contact with each other, and there were no portions of the ovaries or other organs mixed with them, the cubic inch would contain 500^3, or 125,000,000. Dividing this, as before, by two, to allow for foreign matter, interspaces and errors of measurement, we have about 60,000,000 as the possible number of eggs from a single oyster.

Although each male contains enough fluid to fertilize the eggs of several females, there does not seem to be much difference in the number of individuals of the two sexes. When a dozen oysters are opened and examined, there may be five or six ripe females and no males, but in another case a dozen oysters may furnish several ripe males but no females, and in the long run the sexes seem to be about equally numerous. Oystermen believe that the male may be distinguished from the female by certain characteristics, such as the presence of black pigment in the mantle, but microscopic examination shows that these marks have no such meaning, and that there are no differences between the sexes except the microscopic ones. It is not necessary to use the microscope in every case, however, for a little experience will enable a sharp observer to recognize a ripe female without the microscope. If a little of the milky fluid from the ovary of a female with ripe or nearly ripe eggs, be taken upon the point of a clean, bright knife blade, and allowed to flow over it in a thin film, a sharp eye can barely detect the eggs as white dots, while the male fluid appears perfectly homogeneous under the same circumstances, as do the contents of the ovary of an immature female, or one which has finished spawning. When the eggs are mixed with a drop of water, they can be diffused through it without difficulty, while the male fluid is more adhesive and difficult to mix with the water. By these indications, I was

able in nearly every case to judge of the sex of the oyster before I had made use of the microscope.

In order to fertilize the eggs, all that is necessary is the mixture of the ripe eggs with a little of the ripe male fluid in a drop of water. If the point of a knife-blade be dipped in the fluid from a female and touched to a glass slide, and then dipped into the fluid of a male and touched to the same part of the slide, and a drop of sea water be added, to cause the two to meet, most of the eggs will be fertilized, and their early stages of development can be studied in a single drop of water, but to secure the fertilization and healthy development of large numbers of eggs, several precautions are necessary, as well as a few instruments and pieces of apparatus.

The following is a list of the things needed for procuring, fertilizing and hatching the eggs: A pair of sharp-pointed scissors; a pair of small forceps; half a dozen watch crystals; a set of about half a dozen glass beakers, or tumblers, of different sizes, from half a pint up to half a gallon; two or three dipping tubes, or glass tubes six or eight inches long, open at both ends, but with one end drawn out to a fine point; a small glass or rubber siphon for drawing the water out of the beakers. For tracing the development of the eggs, a microscope, magnifying at least one hundred diameters, and half a dozen glass slides and thin glass covers are wanted.

After the oysters have been opened, and at least one ripe male and one ripe female found, cut off the mantle lobes and gills of the male with the scissors, close to the visceral mass, and tear them out with the forceps and throw them away. Cut around the adductor muscle with the scissors, so that the visceral mass may be lifted out of the shell and transferred to a small saucer or to a watch crystal. Holding the visceral mass with the forceps, cut out with the scissors as much as possible of the digestive organs and liver and throw them away, and then chop up the reproductive organs with the scissors, picking out and throwing away any fragments of the liver, digestive organs, mantle or gills which may present themselves. In order to have the young oyster thrive, the

water must be kept free from fragments of the various organs of the adult, as these would soon decay and destroy the embryos, and it is therefore important to remove them as completely as possible. After the mass has been chopped up as fine as possible, fill up the watch crystal with fresh sea water, stir it up, and then allow it to run into one of the smallest beakers, which has been nearly filled with sea water. As the water runs out of the watch crystal, be careful to allow as few of the fragments as possible to run with it.

Now fill up the watch crystal with water again, and stir and pour off as before, and repeat the process until nearly all of the male fluid has been washed out of the fragments and poured into the beaker. Stir the contents of the beaker for a short time, and then allow it to stand about five minutes, to allow any fragments to settle to the bottom, then pour the fluid, which should be quite milky, into another small beaker, leaving behind, to be thrown away, any particles which may have settled to the bottom. The male cells retain their full vitality for several hours after they have been mixed with sea water, so the beaker may be set aside to wait until the eggs are ready. The eggs swell up and break to pieces within a very few minutes after they are mixed with water, unless they are fertilized at once, so it is much better to add the eggs to a previously prepared mixture of male cells and water than it is to put the eggs into the water to wait until the male fluid is got ready.

Taking now one of the females, remove and chop up the ovary in the same way in another watch crystal, observing the same precautions in removing all portions of the body. Fill the watch glass with water, and stir and pour off into the beaker as before, giving the contents of the beaker a good stirring after each lot of eggs is added, in order to diffuse them through the water at once, and thus insure the speedy contact of each of them with some of the male cells.

Fill the crystal with water again, and stir and pour off, and repeat until all the eggs have been washed out of the fragments of the ovary.

Another female may now be cut up, and the eggs may be added to the contents of the same beaker, but if the females are large, and yield many eggs, it is not best to use more than one, for although there are enough male cells to fertilize a very great number of eggs, the eggs are heavier than water and soon sink to the bottom, and if they form a very thick layer, only those which lie near the surface have room to develop.

The beaker should now be allowed to stand for about ten minutes, and in the meantime some of the eggs may be picked out with a dipping tube for examination under the microscope. In using the dipping tube, cover the large end with the tip of the finger, and run the small end down close to the bottom of the beaker, and then take the finger off the top, and as the water runs in at the bottom it will carry some of the eggs with it. When the tube is filled, place the finger on the top again, and draw it out of the water, and, holding it perpendicularly on the centre of a glass slide, and taking the finger off the top, allow a good sized drop to run out into the slide.

If things are working properly, each egg should now have a number of male cells attached by their heads to its outer surface, with their tails radiating from it in all directions, as shown in Figure 51.

It is not necessary that more than one male cell should fasten onto each egg, but they usually cover them in such numbers that the lashing of their tails causes the eggs to rotate and move through the water.

As soon as all the eggs have male cells attached to them, it is necessary to get rid of the superfluous male fluid, for it would soon decay and pollute the water if it were allowed to remain, and if it is not drawn off from the eggs while they are at the bottom, it is almost impossible to remove it after the embryos have begun to swim, without loosing them as well.

After a final stirring, the beaker should be allowed to stand for about five minutes, to allow the eggs to settle to the bottom, and the fluid above them should then be drawn off

through a siphon, reaching nearly but not quite down to the eggs. A fresh supply of sea water should then be added, and the eggs stirred and allowed to settle, and the water drawn off as before, and this should be repeated until the water, after the eggs have settled to the bottom, remains clear.

The beaker may now be set aside where it will not be exposed to sudden changes of temperature, and the eggs will require no further attention until the embryos begin to swim, which will be in from two to six hours, according to the temperature. The little oysters must of course be supplied with fresh sea water from time to time during their development, and as they are so small that the water cannot be drawn off after they begin to swim, they must be supplied with fresh water by transferring them from time to time to larger and larger beakers. In two hours or so after the eggs are fertilized the embryos begin to swim, and crowd to the surface of the water in great numbers, and form a thin stratum close to the surface. This layer of embryos may be carefully siphoned off into a very small beaker, and a little fresh sea water added. In an hour or so there will be a new layer of embryos at the surface of beaker No. 1, and these should also be siphoned into No. 2, and this should be repeated as long as the embryos continue to rise to the surface of the first beaker. Every five or six hours a little fresh sea water should be poured from a height of a foot or more into beaker No. 2, until it is filled. The contents should then be poured into a larger beaker, and sea water added four or five times a day as before. In this way the embryos may be kept alive for a week, although they have by this time got into such a large vessel that it is almost impossible to find any of them for microscopic examination.

THE DEVELOPMENT OF THE EGGS.

I will now attempt a brief popular account of the changes through which the fertilized egg is gradually converted into the complex body of the adult oyster.

The body of the oyster, like that of all animals, except the very simplest, is made up of organs such as the heart, digestive organs, gills and reproductive organs, and these organs are at some period in the life of the oyster made up of microscopic cells. The eggs shown in Figures 49 and 53, will answer to illustrate the character of the cells which compose the body; each of these consists of a layer of protoplasm around a central nucleus, which, in the egg, is a large, circular, transparent body known as the germinative vesicle. Each cell of the body is able to absorb food, to grow and to multiply by division, and thus to contribute to the growth of the organ of which it forms a part. The ovarian eggs are simply the cells of an organ of the body, the ovary, and they differ from the ordinary cells only in being much larger and more distinct from each other; and they have the power, when detached from the body, of growing and dividing up into cells, which shall shape themselves into a new organism like that from whose body the egg came. Most of the steps in this wonderful process may be watched under the microscope, and owing to the ease with which the eggs of the oyster may be obtained, this is a very good egg to study.

About fifteen minutes after the eggs are fertilized, they will be found to be covered with male cells, as shown in Figure 51. In about an hour the egg will be found to have changed its shape and appearance. It is now nearly spherical, as shown in Figure 1, and the germinative vesicle is no longer visible. The male cells may or may not still be visible upon the outer surface. In a short time a little transparent point makes its appearance on the surface of the egg, and increases in size, and soon forms a little projecting transparent knob—the *polar globule*—which is shown in Figure 3, and in succeeding figures.

Recent investigations tend to show that while these changes are taking place one of the male cells penetrates the protoplasm of the egg and unites with the germinative vesicle, which does not disappear, but divides into two parts, one of

which is pushed out of the egg, and becomes the polar globule, while the other remains behind and becomes the *nucleus* of the developing egg, but changes its appearance so that it is no longer conspicuous. The egg now becomes pear-shaped, with the polar globule at the broad end of the pear, and this end soon divides into two parts, so that the egg (Figure 6), is now made of one large mass and two slightly smaller ones, with the polar globule between them.

The later history of the egg shows that at this early stage the egg is not perfectly homogeneous, but that the protoplasm which is to give rise to certain organs of the body, has separated from that which is to give rise to others.

If the egg at the stage shown in Figure 6, were split in the plane of the paper, we should have what is to become one half of the body in one part and the other half in the other. The single spherule at the small end of the pear is to give rise to the cells of the digestive tract of the adult, and to those organs which are to be derived from it, while the two spherules at the small end are to form the cells of the outer wall of the body and the organs which are derived from it, such as the gills, the lips and the mantle, and they are also to give rise to the shell. The upper portion of the egg in this and succeeding figures is to become the ventral surface of the adult oyster, and the surface which is on the right side in Figure 6 is to become the anterior end of the body of the adult. The figure therefore shows the half of the egg which is to become the left half of the body. The upper portion of the egg soon divides up into smaller and smaller spherules, until at the stage shown in Figures 24, 25 and 26, we have a layer of small cells wrapped around the greater part of the surface of a single large spherule, and the series of figures shows that the latter is the spherule which is below in Figure 6. This spherule now divides up into a layer of cells, and at the same time the egg, or rather the embryo, becomes flattened from above downward, and assumes the shape of a flat oval disk. Figures 29 and 30, are views of the upper and lower surface of the embryo at about this time.

In a sectional view, Figure3 1, it is seen to be made up of two layers of cells; an upper layer of small transparent cells, *ec*, which are to form the outer wall of the body, and which have been formed by the division of the spherules which occupy the upper end of the egg in Figure 25, and a lower layer of much larger, more opaque cells, *g*, which are to become the walls of the stomach, and which have been formed by the division of the large spherule, *a*, of Figure 25.

This layer is seen in the section to be pushed in a little towards the upper layer, so that the lower surface of the disk-shaped embryo is not flat, but very slightly concave. This concavity is destined to grow deeper until its edges almost meet, and it is the rudimentary digestive cavity. A very short time after this stage has been reached, and usually within from two to four hours after the eggs were fertilized, the embryo undergoes a great change of shape, and assumes the form which is shown in three different views in Figures 32, 33, 34 and 35.

A circular tuft of long hairs or cilia has now made its appearance at what is thus marked as the anterior end of the body, and as soon as these hairs are formed they begin to swing backwards and forwards in such a way as to constitute a swimming organ, which rows the little animal up from the bottom to the surface of the water, where it swins around very actively by the aid of its cilia. This stage of development, Figure 32, which is of short duration, is of great importance in raising the young oysters, for it is the time when they can best be siphoned off into a separate vessel and freed from the danger of being killed by the decay of any eggs which may fail to develop. On one surface of the body at this stage, the dorsal surface, there is a well marked groove, and when a specimen is found in a proper position for examination, the opening into the digestive tract is found at the bottom of this groove. Figure 33, is a sectional view of such an embryo. It is seen to consist of a central cavity, the digestive cavity, which opens externally on the dorsal surface of the body by a small orifice, the primitive mouth, and which is surrounded at all points, except at the mouth, by a wall

which is distinct from the outer wall of the body. Around the primitive mouth these two layers are continuous with each other.

The way in which this cavity, with its wall and external opening, has been formed, will be understood by a comparison of Figure 33, with Figure 28. The layer which is below in Figure 28 has been pushed upwards in such a way as to convert it into a long tube, and at the same time the outer layer has grown downwards and inwards around it, and has thus constricted the opening. The layer of cells which is below in Figure 28 thus becomes converted into the walls of the digestive tract, and the space which is outside and below the embryo, in Figure 28, becomes converted into an inclosed digestive cavity, which opens externally by the primitive mouth.

This stage of development, in which the embryo consists of two layers, an inner layer surrounding a cavity which opens externally by a mouth-like opening, and an outer layer, which is continuous with the inner around the margins of the opening, is of very frequent occurrence, and it has been found, with modifications, in the most widely separated groups of animals, such as the star-fish, the oyster and the frog, and some representatives of all the larger groups of animals, except the Protozoa, appear to pass during their development through a form which may be regarded as a more or less considerable modification of that presented by our oyster embryo. This stage of development is known as the *gastrula* stage.

Certain full grown animals, such as the fresh water hydra and some sponges, are little more than modified gastrulas. The body is a simple vase, with an opening at one end communicating with a digestive cavity, the wall of which is formed by a layer of cells, which is continuous around the opening with a second layer which forms the outer wall of the body. This fact, together with the fact that animals of the most widely separated groups pass through a gastrula stage of development, has lead certain naturalists to a generalization, which is known as the "gastrula theory." This theory or hypothesis is that all animals, except the Protozoa, are more or less direct

descendants of one common but very remote ancestral form, whose body consisted of a simple two-walled vase, with a central digestive cavity opening externally at one end of the body.

Hæckel, who is the originator and leading advocate of this hypothesis, has proposed to call this ancestral form a "Gastraea;" and the gastrula stage of development he regards as a trace or indication of this distant ancestry, which is still retained and passed through during the early stages of the development of animals which are now very widely separated.

The gastrula theory cannot be regarded as one of the established generalizations of science, and the evidence which has so far been accumulated by embryologists is not by any means straightforward or satisfactory. The theory is one of the most interesting embryological problems under discussion, however, and any new information which bears upon it is of value.

The fact that the oyster goes through a very well marked and very slightly modified gastrula stage is therefore of great theoretical interest, and more so since Salensky, a distinguished Russian embryologist, has proposed in place of the gastrula theory another theory, which is based, in part, upon erroneous observations upon the development of the oyster, which Salensky says does not pass through the gastrula stage of development at all, but forms a digestive cavity in another way.

The edges of the primitive mouth of the oyster continue to approach each other, and finally meet and unite, thus closing up the opening, as shown in Figure 36, and leaving the digestive tract without any communication with the outside of the body, and entirely surrounded by the outer layer. The embryo shown in Figures 32 and 36 are represented with the dorsal surface below, in order to facilitate comparison with the adult, but in Figure 37, and most of the following figures, the dorsal surface is uppermost, for more ready comparison with the adult. The furrow in which the primitive mouth was placed still persists, and soon a small irregular plate makes its appearance at each end of it. These

little plates are the two valves of the shell, and in the oyster they are separated from each other from the first, and make their appearance independently.

Soon after they make their appearance, the embryos cease to crowd to the surface of the water, and sink to various depths, although they continue to swim actively in all directions, and may still be found occasionally, close to the surface. The region of the body which carries the cilia now becomes sharply defined, as a circular projecting pad, the *velum*, and this is present and is the the organ of locomotion at a much later stage of development. It is shown at the right side of the figure in Figure 37, and in Figure 45 it is seen in surface view, drawn in between the shells, and with its cilia folded down and at rest, as they are seen when the little oyster lies upon the bottom.

The two shells grow rapidly, and soon become quite regular in outline, as shown in Figures 37 and 44, but for some time they are much smaller than the body, which projects from between their edges around their whole circumference, except along a short area, the area of the hinge, upon the dorsal surface, where the two valves are in contact.

The two shells continue to grow at their edges, and soon become large enough to cover up and project a little beyond the surface of the body, as shown in Figure 44, and at the same time muscular fibres make their appearance and are so arranged that they can draw the edge of the body and the velum in between the edges of the shell, in the manner shown in Figure 45. In this way that surface of the body which lines the shell becomes converted into the two lobes of the mantle, and between them a mantle cavity is formed, into which the velum can be drawn when the animal is at rest. While these changes have been going on over the outer surface of the body, other important internal modifications have taken place. We left the digestive tract at the stage shown in Figure 36, without any communication with the exterior.

Soon the outer wall of the body becomes pushed inwards, to form the true mouth, at a point (Figure 37), which is

upon the ventral surface, and almost directly opposite the point where the primitive mouth was situated at an earlier stage. The digestive cavity now becomes greatly enlarged, and cilia make their appearance upon its walls, the mouth becomes connected with the chamber which is thus formed, and which becomes the stomach, and minute particles of food are drawn in by the cilia, and can now be seen inside the stomach, where the vibration of the cilia keep them in constant motion. Up to this time the animal has developed without growing, and at the stage shown in Figure 36 it is scarcely larger than the unfertilized egg, but it now begins to increase in size. The stages shown in Figures 44 and 45 agree pretty closely with the figures which European embryologists give of the oyster embryo at the time when it escapes from the mantle chamber of its parent. The American oyster reaches this stage in from twenty-four hours to six days after the egg is fertilized; the rate of development being determined mainly by the temperature of the water.

Soon after the mantle has become connected with the stomach, this becomes united to the body wall at another point a little behind the mantle, and a second opening, the *anus*, is formed. The tract which connects the anus with the stomach lengthens and forms the intestine, and, soon after, the sides of the stomach become folded off to form the two halves of the liver, as shown in Figure 44.

Various muscular fibres now make their appearance within the body, and the animal assumes the form shown in Figures 44 and 45.

All my attempts to get later stages than these failed, through my inability to find any way to change the water without losing the young oyster, and I am therefore unable to describe the manner in which the swimming embryo becomes converted into the adult, but I hope that this gap will be filled, either by future observations of my own or by those of some other embryologist.

In my attempt to raise the oyster embryo from the egg, I found that continuous warm weather was essential to success.

As my observations upon the developing eggs occupied all my time, I was not able to make any record of the temperature of the water of the ocean, but during June there were a number of cold, windy days and nights, and two hail-storms, and on each of the cold days all the embryo which I had in the house died.

Before I close this portion of my paper, I wish to call attention to some points of general interest, which have suggested themselves to me during the prosecution of my work.

At first sight it does not seem possible that an animal which is encased in a hard, strong, protecting shell, and which is capable of giving rise to several million eggs every season, can be in any danger of extermination; and it seems as if the oyster ought to be able to hold its own in the struggle for existence, and to increase and multiply in the face of the most adverse circumstances.

It appears wonderful that the waters of the Chesapeake Bay are not paved with oysters, and persons who have not given much thought to the subject will ridicule the statement that there is any need for measures to prevent their extermination or the destruction of the natural beds. While the consumption of oysters was restricted to regions in the immediate vicinity of the beds, the number of oysters which it would pay to gather and put into the market each season from each bed was limited; but with the present facilities for packing and transporting oysters, there is no limit to the number which can be utilized, and the danger of destroying the best beds grows greater every day, and keeps pace with the increasing population and improvements in transportation.

Those who believe that the abundance of the supply up to the present time is sufficient proof that it will continue, will do well to reflect upon the facts given in the following table, which I have condensed from a recent book on the oyster, by Möbius (Die Austern und die Austernwirtschaft, Möbius, Berlin, 1877, page 67.) He gives a long table, showing the number of oysters taken yearly from the Bay of Cancale, on the coast of Norway, for about one hundred years, and I have copied enough from it to show its character:

In the	year	1800	the	number	of	oysters	taken	was	1,200,000
" "	"	1820	"	"	"	"	"	....	6,000,000
" "	"	1825	"	"	"	"	"	....	20,000,000
" "	"	1830	"	"	"	"	"	....	34,000,000
" "	"	1835	"	"	"	"	"	....	43,000,000
" "	"	1840	"	"	"	"	"	....	52,000,000
" "	"	1845	"	"	"	"	"	....	67,000,000
" "	"	1847	"	"	"	"	"	....	71,000,000
" "	"	1850	"	"	"	"	"	....	50,000,000
" "	"	1855	"	"	"	"	"	....	20,000,000
" "	"	1860	"	"	"	"	"	....	8,000,000
" "	"	1865	"	"	"	"	"	....	1,100,000
" "	"	1868	"	"	"	"	"	....	1,079,000

Previous to the year 1800, and from this date to 1825, the number taken each year was small, and did not average more than five or six million oysters, and the enormous numbers which were taken from the beds in late years show that the removal of this moderate number yearly had no tendency to destroy the beds. It seems quite evident from the figures that the bed might have yielded twenty million oysters a year for an indefinite period, and the figures given for the years after 1825 are therefore highly instructive, for they show that a bed which is capable of furnishing a very great supply of oysters may be completely exterminated within a comparatively few years by unlimited dredging.

The table also shows that it will not answer to rely upon the very great number of eggs, and therefore trust to a few oysters the work of replenishing the bed.

In view of such facts, no one who appreciates the magnitude of the oyster industry of the Chesapeake can doubt that the protection of the natural oyster beds is a matter which is worthy of the most careful attention. While the manner in which this is to be accomplished is outside the scope of the present paper, a statement of those favorable and unfavorable influences which have suggested themselves to me during my work, may fairly find a place here.

It is well known to naturalists that the number of individuals which reach maturity in any species of animals or plants does not depend upon the number which are born. The

common tape-worm lays hundreds of millions of eggs in a very short time, yet it is comparatively rare. The number of children born to each pair of human beings during their life-time of from fifty to eighty years, can be counted on the fingers, yet man is the most abundant of the larger mammals, and human population increases quite rapidly under favorable circumstances. This comparison shows plainly that the abundance of a species is determined, mainly, by the external conditions to which it is exposed, and that the number of individuals which are born has very little to do with it. In the case of the oyster, the adult is well protected against enemies by the shell, and as its food is abundant, and is brought to it by the water, it is tolerably sure of a long life after it has reached its adult form, but the life of the young is very precarious; that of the young American oyster peculiarly so, since it is exposed to all kinds of enemies and accidents, at a time when it is most helpless. The protection of the young European oyster by the parent shell at this time would seem to more than balance the greater number of eggs laid by the American.

The most critical time in the life of the American oyster is undoubtedly the time when the egg is discharged into the water to be fertilized, for the chance that each egg which floats out into the ocean to shift for itself will immediately meet with a male cell is very slight, and it is essential that the egg should be fertilized very quickly, for the unfertilized egg is destroyed by the sea water in a very short time. The next period of great danger is the short time during which the embryos swarm to the surface of the water. They are so perfectly defenceless, and so crowded together close to the surface, that a small fish, swimming along with open mouth, might easily swallow in a few mouthfulls a number equal to the human population of Baltimore. They are also exposed to sudden changes of temperature, and as my experiments have shown that a sudden fall in temperature is fatal to them at this time, the number which are destroyed by cold rains and winds must be very great indeed.

As soon as they are safely past this stage, and scatter and

swim at various depths, their danger from accidents and enemies is greatly diminished, and their chance of reaching maturity increases hundreds, and probably thousands of times.

My experiments show that there is no difficulty in developing them up to this point in the house in small aquaria, and in carrying them safely past the most precarious part of their lives, and freeing them from all their greatest dangers.

Although the mortality at these early stages is so excessive, the number of young which pass through them safely without help is very great, and if there were no other dangers and uncertainties there would be no need of measures for their protection. As they swim to and fro in the water, they are carried to great distances by the tides and currents and reach all parts of the region of water in which the parent bed is situated. In a favorable year a floating plank or bush, or piece of drift-wood, will be found to become covered with small oysters which have fastened to it, although it may not be within miles of any natural oyster bank. The fact that the young may be collected in this way in any part of the Chesapeake Bay shows that the young oysters must settle down upon the bottom in nearly all parts of the bay, and we should expect the adults to have an equally general distribution. This is far from the case, and nothing could be farther from the truth than the idea that the bottom of the waters of the oyster regions is uniformly covered with oysters, and that it is only necessary to throw a dredge overboard and drag it along the bottom for a short distance, in order to bring it up full. Nothing could be a greater mistake, for both in this country and in Europe, the oysters are restricted to particular spots, "beds" or "banks," which are as well defined and almost as sharply limited as the tracts of wood-land in a farming country. These beds are so well marked that they can be laid down on a chart or staked out with buoys; and even in the best oyster regions they occupy such an inconsiderable part of the bottom that any one ignorant of their position would have very little chance of finding oysters by promiscuous dredging. Although the young are distributed every year, by the tides and currents, to all parts of the bottom, the dredge very seldom brings up even a single oyster outside the limits of the beds.

The restriction of the oysters to certain points does not appear to depend upon the supply of food, or upon the character of the water, but almost entirely upon the nature of the bottom. The full-grown oyster is able to live and flourish in soft mud, as long as it is not buried too deeply for the open edge of the shell to reach above the mud, and draw a constant supply of water and food onto the gills. The placing of adult oysters upon such bottoms at convenient points, to "fatten" for the market, is a well-known practice. The oyster embryo would be ingulfed and smothered at once if it should settle down upon such a bottom, and in order to have the least chance of survival and long life the young oyster must find some solid substance to fasten itself to, in order to preserve it from sinking in the soft mud or from being covered by shifting sand or gravel. As soon as the young oyster finds such a solid body, rough and clean, it fastens one valve of its shell to it by secreting a cement of shelly matter around the growing edge.

The living and dead shells of the adult oysters furnish the best surfaces for the attachment of the young, and for this reason the points where oyster beds are already established are those where the young have the most favorable surroundings and the best chance for life, and the beds thus tend to remain permanent and of substantially the same size and shape.

At the time of attachment the shell of the young oyster is still very thin and delicate, and the animal falls an easy victim to the numerous enemies which abound upon the oyster beds, such as crabs of various sorts, carnivorous gasteropods and various fishes.

It is not an uncommon thing for fifty or a hundred young "spat" to attach themselves to one full-grown shell. Some of these are killed by enemies, and others are crowded out, so that only a few grow up at the expense of the others, and the number which survive is astonishingly small. Möbius has made an attempt to ascertain what chance of survival the newly-hatched oyster has. The ratio between half-grown and adult oysters in the oyster beds of Schleswig-Holstein has

been ascertained and recorded, at intervals of a few years, for more than a century, by a systematic method of counting the contents of a certain number of sample dredgings. From a Danish book on the subject (Der Danske Osterbanker, by H. Kroyer, Kjöbenhaven, 1839), and from other sources, he obtains the following series of ratios:

In 1730	there	were	486	half-grown	oysters	to every	1,000	full-grown	ones.
" 1734	"	"	310	"	"	"	1,000	"	"
" 1740	"	"	418	"	"	"	1,000	"	"
" 1756	"	"	490	"	"	"	1,000	"	"
" 1775	"	"	484	"	"	"	1,000	"	"
" 1799	"	"	307	"	"	"	1,000	"	"
" 1819	"	"	388	"	"	"	1,000	"	"
" 1830	"	"	417	"	"	"	1,000	"	"
" 1839	"	"	440	"	"	"	1,000	"	"
" 1852	"	"	473	"	"	"	1,000	"	"

or an average of 421.2 to 1,000, or 42.13 per cent. of young. The uniformity of the ratio between the half-grown and the adult oysters, through a period of more than one hundred years, is very remarkable. In no case was there less than 30 per cent. of young or more than 50 per cent., and the average of 42 per cent. is very closely followed After an oyster has become half-grown its dangers are very few, and this number—42—probably gives with sufficient accuracy the number of oysters which grow up each year for each 100 adults. Although the number of young which are born each year is great beyond computation, those which survive are less than half as numerous as the adults.

Möbius has estimated the number of adults which spawn each year, and multiplying this number by the average number of eggs laid by each, and dividing by the number which grow up, he reaches the conclusion that each oyster which is born has $\frac{1}{1,145,000}$ of a chance of reaching maturity. In the case of the American oyster, the number of eggs is very much greater, and each one's chance of survival is accordingly very much less, and it is evident that the great fertility of the oyster will not protect a bed from destruction by excessive dredging, for while the young spat frequently cover the

shells of the adults by hundreds, the number of half-grown oysters is always less than one-half the number of adults. The great mortality of the young, after they have fastened themselves to the shells of the adults, is due in part to want of room, in part to the attacks of enemies, in part to accidents, such as the shifting of the bottom, and in part, no doubt, to lack of food. While the supply of organic matter which is carried to them by the water is very great, it is not unlimited, and the amount which each oyster can obtain at any one time is quite small, and if the oysters covered the bottom in sufficient abundance, some of them might fail to obtain a sufficient supply. I do not believe, however, that this ever occurs, for long before the oysters are sufficiently abundant to exhaust the supply of organic matter, their numbers are limited by other conditions. The growth of an animal does not depend upon the supply of food in general, but upon the supply of the least abundant of the necessary ingredients of the food. It is well known that a field that is very fertile will fail to produce a satisfactory crop of a plant which needs some particular food-ingredient which the soil contains in too small quantity. Although food in general is very abundant, the growth of this particular crop depends upon the amount of this ingredient, and while the seed which has been planted yields an abundant crop of young plants, only a few are able to grow up, and these can grow no faster than they can extract this particular ingredient from the soil.

In addition to organic food, the oyster needs a supply of carbonate of lime to make its shell, and this is supplied to it, in solution, in sea-water. If the shell is thin, or if it is formed very slowly, the danger from enemies and accidents is greatly increased; and those oysters which are able to construct their shells with the greatest rapidity are the ones which survive and grow up. The amount of dissolved carbonate of lime which the ocean contains is unlimited, but the amount which can reach each oyster is not very great; and if all the oysters which attach themselves were to survive there can be no doubt that they would exhaust the available supply of lime before they failed to obtain enough organic food.

It is well known that shell-fish of all kinds thrive best when the supply of lime is greatest. The fresh-water mussels which live in streams and ponds where the supply of lime is scanty, grow slowly, and their shells are so thin that they are very subject to accidents, and their numbers are limited; but in limestone regions the shells are large and heavy, and the bottoms of the streams are almost paved with mussels, and it is well known to conchologists that coral reefs and islands are the most favorable regions for the abundant growth of all kinds of shelled molluscs.

The dead oyster-shell is soon corroded, and in a few years entirely dissolved, by the sea-water; and I think this fact is another reason why the young oysters thrive best on a natural oyster-bed.

How far the supply of oysters is limited by the supply of lime it is impossible to say; but when we recollect how important it is that the young oysters should soon find solid bodies to fasten themselves to, and that they should protect themselves by strong shells of their own as quickly as possible, it will be seen that the danger of exterminating a natural bed by over-dredging would be much less if the empty shells were replaced upon the bed. There can be no doubt that the best natural beds may be destroyed by over-dredging, and that this fate will be certain to overtake the beds of the Chesapeake Bay if the oyster industry continues to increase, and matters are left to adjust themselves.

Like most dangers, this is one which will not become conspicuous until it is too late to find a simple remedy.

Whether the number of oysters which are at present taken from our oyster beds is too great or not is a matter which is outside the field which I undertook to investigate, but it is a matter in which the public have the greatest interest, and the extent of the oyster beds, and the number of oysters which they can supply each year, should be accurately ascertained before it is too late.

A prophet of future evil is always regarded as an unseasonable croaker, but the facts which I have noticed seem to show that, whether the danger of exterminating the best and most

accessible oyster beds is near or remote, it is sure to force itself upon us some time. If we wait for that time the remedy will be slow and expensive, but prevention of the danger in time would not necessarily be attended with any very great expense.

The investigation into the hydrography and general condition of the oyster beds of Tangier and Pokamoke Sounds, which has been so ably conducted by Captain Winslow, of the United States Coast Survey, during the past two summers, will supply the necessary information; and should these investigations show that any of these beds are in immediate need of artificial help to save them from destruction, I hope that the observations I have detailed in this paper may point to the way in which this help may be given.

PART II—EMBRYOLOGY.

THE SEXES OF THE OYSTER.

A list of the contradictory opinions which various writers have expressed regarding the distinctness of the sexes of the oyster is hardly worth publishing, since all the thoroughly competent observers who have investigated the subject in modern times agree that each oyster is, at the breeding season, either a male or a female.

During my investigations I submitted more than a thousand oysters to microscopic examination. My studies were carried on during the breeding season, and I did not find a single hermaphrodite. The male cells are so small compared with the eggs that it would be impossible to state that a mass of eggs taken from the ovary contained no spermatozoa, although they could not escape detection if they were at all abundant.

On the other hand, a single egg in the field of the microscope in a drop of male fluid would be very conspicuous, and could not escape detection; and the fact that not a single case of this kind occurred is sufficient to establish the distinctness of the sexes at the breeding season.

A short time since, October 25th, I examined a number of oysters with the same result. I found six females with ovaries filled with nearly ripe ovarian eggs, and eight males whose testes were filled with spermatozoa, most of which were immature, but some of them fully developed and active.

One of the males and one female were hardened in chromic acid, and a number of microscopic sections were cut from various parts of the reproductive organs of each. None of the ovarian follicles or parts of follicles of the female contained anything but eggs, and not a single egg at any stage of development was found in any part of the body of the male.

In order to show how conspicuously the characteristics of the sexes are shown in these sections I have made careful drawings of two of them. Figure 53 is a section of part of the visceral mass of the female, showing nine ovarian follicles cut in various directions. Each follicle contains a nearly central cavity, and around this, on all sides, the opaque granular eggs project from the basement membrane of the follicle, to which they are attached either directly or by long stalks. Each egg contains a large, conspicuous, oval, transparent nucleus, and a single nucleolus, which is on that side of the nucleus which is nearest the point of attachment to the membrane. The eggs are so crowded that they are flattened and rendered polygonal by mutual pressure, and in some places there is a very regular alternation of those with and those without stalks.

Figure 67 is a section of a portion of the visceral mass of a male, as seen with the same magnifying power. The space nearest the basement membrane of each follicle is here occupied by a thick layer of small cells, the mother cells of the spermatozoa, and the centre of the follicle, instead of being empty, as in the female, is filled with a mass of spermatozoa, which have been set free. Some of the follicles shown in this section open by slightly constricted orifices into a large oval duct, with a lining of epithelial cells. These ducts are filled with nearly ripe spermatozoa, which have been forced into them from the follicles, and even in the hardened specimen traces of the movement of the spermatozoa from the cavities of the follicles into that of the duct are retained. A comparison of this figure with the one just described shows the male follicle to be so different from the female follicle in structure and appearance that the occurrence of a male follicle in a section of the ovary, or of a female follicle in a section of the testis, could not escape instant detection, and it is also plain that one of the very characteristic ovarian eggs shown in Figure 53, could hardly fail to attract attention at once if it should occur in a section of the testis.

My observations tend to show, then, that the sexes are separate in the American oyster of the Chesapeake Bay during

the summer months and up to the end of October, but the present season has been unusually mild, and Capt. Winslow, U. S. N., tells me that he found oysters in October of this year in Tangier Sound, the eggs from which he succeeded in fertilizing. It is possible, then, that those which I examined were ready to spawn this season. If this is so, all my observations have been made during the breeding season, and it may be possible that later in the year hermaphrodite individuals may be found. There is nothing improbable in the statement that oysters change their sex, and that an individual may be a female one year and a male another year, but my observations certainly do not indicate that this is the case with the American species.

The only observations which I have met with on this subject, made in this country, are by McCrady (Observations on the Food and Reproductive Organs of Ostrea Virginiana, with some Account of Bucephalus Cuculus: Proceedings Boston Soc. Nat. Hist., December 3d, 1873, pp. 170–192). He says that at a time when the ovarian eggs are very small and immature "the spermatozoa may be seen in their aggregated or even their free condition, actively moving about among masses of granular yolk substance, inclosing many germinative vesicles, without exhibiting any attraction for them, and without the appearance of any change in the young vesicles themselves." (Page 172.)

Regarding the oysters nearer the breeding season, when the eggs were more mature, he says, p. 174: "I endeavored next to ascertain whether or not spermatozoa were present, but could not satisfy myself on this point, as my eye had become fatigued, and no disposition of the light enabled me to discover whether the minute dancing cellules, which were quite numerous, had or had not a tail."

This observation would seem to indicate that, while the sexual elements are immature, both male and female elements may occur in the same individual.

The most thorough and satisfactory observations upon the sex of the European oyster are those by Möbius, and his account shows that the sexes are separate at the breeding

season. His observations were published in 1871, under the title "Untersuchungen über die Fortpflanzungsverhältnisse der Schleswigschen Austern. Nachr. der deutchen Malak. Gesellsch. III, 1871. Abstr. in Hoffmann u. Schwallbe's Jahresberichte, 2, 1873, p. 338. In his most recent publication on the oyster (Der Auster und die Austern-wirtschaft, Berlin, 1877), he reviews the subject and says, p. 19: "Die Austern sind Zwitter. In einer grösseren Zahl Austern fande ich in der ganzen Geschlechtsdrüse nur Befruchtungskörper, aber keine eier. Bei 7 Austern, die blau Brut im Barte trugen enthielt die Geschlechtsdrüse Befruchtungskörper."

It would seem to be at least as probable that these seven oysters were males which had drawn floating embryos in onto their gills as that they were females which had changed to males after laying all their eggs.

"Drei Austern mit jüngeren weissen Keimen im Barte hatten keine Befruchtungskörper in der Geschlechtsdrüse. Bei den meistern Keimenträchtigen Austern enthielten der Geschlechtsdrüse weder Eier noch Befruchtungskörper. Von 309 Austern, welche am 25 Mai auf vier verschiedenen Bänker im Osten der Insel Sylt gefischt und von 26 Mai bis 1 Juni untersucht wurden, waren 18 Procent geschlechtlich unentschieden, dei übrigen 82 Procent waren zur Hälfte eierträchtig, zur Hälfte spermaträchtig. Bie keiner waren die Geschlechtsproducte ausgereift. Aus diesen Befunden schliesse ich dass in der Geschlechtsdrüse der Austern nicht gleichzeitig, sondern folgzeitig Eier und Befruchtungskörper entstehen; dass Befruchtungsköper sehr bald nach dem Ausstossen der Eier entstehen können, und dass wahrscheinlich der eine Hälfte der Austern einer Gebietes in einer Brutperiod blos Eier die andere Hälfte blos Sperma bildet."

His conclusion that the sex of the oyster changes after the reproductive elements have been discharged from the body, is thus seen to rest upon the occurrence of spermatozoa in the reproductive organs of oysters whose gills carried embryos, but as it seems perfectly possible that these might have escaped from the mantle chambers of the oysters, and thus gained access to the gills, there is no proof that these oysters had ever acted as females.

Lacaze-Duthier's observations, published more than twenty years ago (Ann. d. Sc. Nat. 1854. Organes génitaux des Acéphales Lamellibranches.; and, Comptes rendus, 1855, x 4, 415–420. Des organes de la generation de l'huitre), are very similar to those of Möbius. He says that at any given time each oyster is almost exclusively male or almost exclusively female, and he thinks that the young oysters are functionally male, and become female as they grow older.

As I have already stated, I have found oysters only one year old which contained ripe eggs, and eggs only, and others of the same age which were exclusively male, and I have succeeded in fertilizing the eggs of the one with the fluid of the other. This observation, which is corroborated by Gerbe's statement (Zool. Record, 1876, xiii., Mol. p. 62), that among 435 European oysters one year old, he found 35 with young; 127 with ripe eggs, and 189 with ripe semen, seems to be sufficient to show the incorrectness of Lacaze-Duthier's conjecture that the functionally male condition precedes the functionally female condition.

MANNER OF FERTILIZATION.

Although the American oyster seems well adapted, like the European species, and various other marine and fresh-water Lamellibranchs, to draw into its mantle-chamber, with the sea-water, the spermatozoa discharged from the mantle-chambers of neighboring oysters, and thus to bring about the fertilization of the eggs inside the cavity of the shell, this does not seem to occur.

I have carefully searched the gills and mantles of more than a thousand oysters at a time when the reproductive organs were plainly seen to be discharging their ripe contents, and have not found a single fertilized egg or embryo in any part of the mantle-chamber, in or on the gills, or anywhere else inside the shell. This negative evidence, together with the fact that the eggs can be hatched after they have been artificially removed from the ovaries seems sufficient to prove, in the absence of all evidence to the contrary, that the eggs of the American oyster undergo development in the open ocean.

The various observations which have been published regarding the place where the eggs are fertilized in the European oyster are very contradictory.

In 1827 Home stated (Phil. Trans. 1827,) that the eggs are impregnated inside the ovaries; but as his paper also states that the rotation of the ciliated embryo is caused by a parasitic worm, it is doubtful whether the means at his command were adequate to the solution of the question.

In the "Report of the Commission appointed to Examine into the Methods of Oyster Culture in France and in the United Kingdom with a view to the Introduction of Improved Methods of Culture of the Oyster into Ireland, 1870," J. G. Hart, Esq., one of the Commissioners, says, p. 10: "Artificial fecundation, such as is practiced with the Salmonidae, is impossible, from the fact that fecundation takes place before the extrusion of the ova from the ovaries, and therefore we must conclude that with the oyster the utmost that can be done by so-called artificial breeding is not the procuring of artificial impregnation, but only the shepherding of the impregnated ova during infancy." The five original figures which he gives, pp. 9 and 11, Figs. 1, 2, 3, 4 and 5, as well as his account of the early stages of the oyster, are so crude and indefinite as to throw great doubt on the value of his evidence.

In a work entitled "Guide Practique de l'Ostreicultur," Prof. Felix Fraiche makes a similar statement, that since the eggs are fertilized within the ovaries artificial fertilization is impossible, but his statement does not appear to be based upon observation.

Eyton, who appears to be a thoroughly competent observer, states (History of the Oyster and Oyster Fisheries, by T. C. Eyton, F. L. S., F. Z. S.: London, 1858, p. 21) that in a number of oysters which he has opened and examined at various times, and from different places, embryos, at different stages of development, were present inside the ovaries as well as on the gills. There seems to be no reason for doubting his evidence, but it does not seem to be sufficient to show that the eggs are fertilized exclusively in the ovaries.

Möbius, whose statements rest on careful observation, states

(Die Austern und die Austern-wirtschaft, p. 17) that the oysters discharge their ripe eggs into the gills, and that they commence their development after they have left the reproductive organs

The occurrence of unfertilized eggs on the gills is conclusive evidence that impregnation does not always take place in the ovaries, but it cannot be regarded as evidence that the eggs have not been discharged from the cloaca into the external water, and then drawn back into the mantle chamber. It seems possible that some, at least, of the eggs of the European oyster may be fertilized outside the shell, as is the case with the American species; but there does not at present seem to be any reason to believe that they ever complete their development elsewhere than inside the shell. It is, of course, impossible for an American to decide this point, but I think it is one to which the renewed attention of European naturalists might well be directed.

SEGMENTATION.

The segmentation of the oyster egg is remarkable for its great rapidity, for its bilateral symmetry, and for the very well marked alternation of periods of activity with periods of rest. The rate of segmentation varies greatly according to temperature and other conditions, but in some cases the ciliated embryo is formed within two hours after fertilization. After the completion of the first division the position of the right and left sides, as well as that of the dorsal and ventral surfaces, is determined.

The ripe, unfertilized egg is quite variable and irregular in shape, usually elongated and pear-shaped, but sometimes polyhedral, and without the stalk, round over part of its surface and flattened over part, or even perfectly spherical. The characteristic shapes of the eggs are well shown in 49, 51 and 53. No external membrane is visible in the unfertilized egg, and, as shown in the figures, the protoplasm of the yolk forms a thin, slightly granular layer around the very large oval, transparent germinative vesicle, which again contains a single, more highly refractive, germinative dot. In

from five minutes to an hour after impregnation the egg becomes quite regularly spherical, as shown in Figure 1, and is now covered by a distinct limiting membrane, which adheres closely to the surface of the uniformly granular yolk.

The changes of segmentation take place so very rapidly that the close observation of the living egg demanded all my attention, and I was not able to make any observations upon stained specimens, regarding the fate of the germinative vesicle, or the orgin of the polar globules or formation of the first segmentation nucleus; and the living egg is sufficiently opaque to prevent observations upon this point.

After the egg has assumed the spherical form shown in Figure 1, it remains without change for some time, usually nearly an hour, and then enters upon a period of activity, during which changes follow each other with great rapidity.

The first thirteen figures were drawn from the same egg. As the day was very cold, the changes were slow, and the first period of activity did not set in until two hours and seven minutes after impregnation, but the series of changes shown in Figures 2–13 occupied only seventeen minutes, and this was so much longer than usual that I was able to commence my series of drawings by sketching them.

As shown in Figure 2, the egg commences its activity by elongating and becoming oval, with one end narrower than the other. The narrow end is to become the nutritive pole, and the broad end the formative pole of the segmenting egg. In all the figures of segmenting eggs the formative pole is above, and the nutritive below, and the latter corresponds, in a general way, to the dorsal surface of the embryo.

Contractions now begin to make their appearance at the formative end, throwing the limiting membrane into waves or wrinkles, which travel rapidly towards the formative pole, near which they disappear.

The wrinkles are shown in Figure 2. It is, of course, impossible to show their movement in a drawing, but the progression over the surface of the yolk, from the starting-point at the small end to the place where they disappear near the round end, is well marked, and is a constant characteristic,

which may be found in every egg by patient watching. It is of very short duration, and the limiting membrane usually becomes smooth again in about fifteen seconds after the contractions commence. Before I discovered that similar waves run over the surface of the egg for a few seconds at the beginning of the active changes at later stages of segmentation, I naturally inferred that they were connected with the extrusion of the polar globules. While it seems probable that they are in some way connected with this extrusion, their occurrence at later stages shows that this is not their only significance.

So far as I am aware, this is the first notice of their occurrence.

Soon after the waves commence, an area, which is a little less granular than the mass of the egg, becomes visible at the formative pole, and from this the first polar globule soon begins to protrude, pushing out the external egg-membrane. Figure 3 is the same egg two minutes later, and Figure 4 is the same after another interval of two minutes. The oval outline is now gradually changing to a pear-shape, the stalk of the pear occupying the nutritive pole, and the polar globule projecting from the middle of the broad end of the pear at the formative pole. During these stages the granular matter of the yolk may be seen to flow in a steady, slow current, around the periphery of the egg, but, as far as I could observe, the current has no definite starting-point or terminus. At these stages there are no waves on the surface, and the membrane is smooth. It is interesting to observe that while these changes are taking place the nutritive end of the egg grows a little more transparent than the formative end, a reversal of what occurs in almost all other eggs which pass through unequal or irregular segmentation, although Lovén has described the same phenomenon in Crenella. In a short time three planes of cleavage run in towards the centre of the egg from three equidistant points on the periphery, as shown in Figure 5, which is two minutes later than Figure 4, although the changes usually take place much more rapidly.

One of these planes is at the point occupied by the polar globule, and the others about midway between it and the

nutritive pole, and two of the three nearly equal masses into which the egg is blocked out lie at the formative end, and one at the nutritive end; the latter is less granular than the pear. The three furrows do not tend to meet exactly at the centre, but as shown in Figure 6, two minutes later than Figure 5, the one which runs down from the polar globule inclines to one side so as to meet one of the side furrows before the other. During the stages shown in this and the preceding and succeeding figures the protoplasm of the whole egg is violently disturbed, and the granular matter quivers or dances, with what would be called "Brownian" motion, were it not confined to this particular stage of development. At the stage shown in Figure 5, the three lobes *a*, *b* and *c* of the trefoil are nearly equal in size, but at the present stage, Figure 6, the one at the nutritive end, *a*, is the largest, and the one which is most perfectly separated, *c*, the smallest. The later stages show that this smallest spherule is posterior to the larger one, and this figure therefore gives a view of the left side of the egg or embryo with its dorsal surface below. For the sake of brevity, we may now call the smallest spherule, *c*, of Figure 6, the first micromere, the next largest, *b*, the second micromere, and the one at the nutritive pole, *a*, the macromere.

In one minute after the stage shown in Figure 6 the vertical furrow has united with one of the lateral furrows, to separate off the first micromere, and the second lateral furrow has run in and united with the line thus formed, so that the egg is now divided into three separate masses, each of which now becomes spherical, as shown in Figure 7. This stage ends the first period of activity, and the changes which follow result in the gradual obliteration of the sharply defined characteristics which have been acquired.

In forty-five seconds after the stage shown in Figure 7 the two micromeres, *b* and *c*, have approached and united with each other, as shown in Figure 8, and the second micromere, *b*, has also become fused with the macromere, *a*, although the egg still has its trefoil outline, and is now very similar to the stage shown in Figure 5. In another minute Figure 9, the fusion of the second micromere, *b*, with the macromere, *a*, is

much more marked, and the first micromere *c* has also begun to unite with the macromere. Up to this time the lines of union of the three spherules have been visible, but in another minute, Figure 10, there is no line to indicate the fusion of the second micromere *b* with the macromere *a*, and the primitive distinctness of the two is only indicated by a depression in the outline, which soon disappears entirely, as is shown in Figures 11 and 12. At the same time the first micromere, *c*, becomes more completely united to the mass, *a* and *b*, formed by the fusion of the second with the macromere, although, as shown in Figures 11, 12, 13, 14 and 15, the line of separation never becomes invisible, Of these, Figure 11 is three minutes later than Figure 10, and Figure 12 two and three-quarters minutes later than that. The next figure, 13, is from another egg, but is about two minutes later than 11, and shows the characteristics at the end of the second period of rest. At some time during the stages of which I have been speaking the egg sheds an external membrane, and I have copied this drawing here in order to show the membrane, nearly cast off. It will be seen that the casting of this membrane does not leave the surface of the yolk exposed, but that it is still covered with an investing membrane. I am unable to say whether the membrane was originally more than one layer thick, or whether a new one is formed to replace the one which is shed. The time when the egg escapes from this membrane varies greatly, but it is usually earlier than this stage, and an egg at the stage 10, in the act of escaping, is shown in Figure 46. At the stage 13 the egg is again almost spherical, and consists of two masses, a large one, *a* and *b*, and a small one, *c*, meeting each other upon a flat surface. The preceding stages show that the larger mass is compound, and made up of the macromere and second micromere, but there is no visible indication of this fact. The long axis of the egg, at this stage, does not pass through the polar globule, but parallel to it.

At the stage which corresponds to this the eggs of many molluscs have a segmentation cavity, but there does not seem to be any space between the two spherules of the oyster-egg,

nor does a segmentative cavity make its appearance until much later.

From the stage shown in Figure 1, up to the stage shown in Figure 10, no traces of a segmentation nucleus could be made out in the living egg, but at the stage shown in Figure 11, a large, circular, transparent body appears in the first micromere and another at the formative end of the compound mass formed by the fusion of the second micromere with the macromere.

At the end of the second period of rest (Figure 13), these bodies are much larger, and their outlines are very clear. The commencement of the second period of activity is shown in Figure 14, which is six minutes after Figure 13. The two spherules swell up and become much more conspicuous than they were at the stage before, although they are still in contact over a considerable area. The wave-like motion, noticed at an earlier stage, is now repeated in each spherule, and runs over the surface from the point furthest from the polar globlue towards the end where this is situated; the wave continuing for about half a minute. At the time this motion commences a remarkable change takes place in the two transparent vesicles already mentioned. Each of these becomes irregular and star-shaped, and long channels radiate from it into the substance of the yolk, as shown in Figure 47. The central chamber then instantly disappears; the radiating channels are visible for a fraction of a second longer, and then disappear, and the places which the two large chambers had occupied are now (Figure 14), seen to be occupied by two small refractive nuclei. I at first thought that the radiating channels might be the same as the star-shaped figures of recent embryologists, but it seems more probable that each of the large chambers of Figures 11, 12 and 13, contains a nucleus which might be brought out by reagents, and which is surrounded by a more fluid substance, the diffusion of which through the yolk precedes the formation of the amphiaster and the division of the nucleus. It is possible that this diffusion is the cause of the peculiar star-like arrangement of the granules of the yolk around the nu-

cleus. The disappearance of the large chamber by a sudden contraction, and the diffusion of its contents through radiating channels, are phenomena which are as unmistakable as the somewhat similar changes of the contractile vacuole of an infusorian, although, like the latter, they are somewhat difficult to discover, and can only be seen by keeping the egg under constant observation.

In some instances, I was able to actually observe the disappearance of the germinative vesicle of the oyster egg. In many Lamellibranchs this body has considerable elasticity, and in Anodonta it may be forced by pressure through a small fissure in the ruptured egg-shell, and it will regain its original shape and size after it has escaped from the egg. This is not the case in the oyster, and in the ripe egg the vesicle seems to be almost as fluid as water, and cannot be pressed out of the yolk. Like all the changes in the oyster-egg, the disappearance of the germinative vesicle takes place with great rapidity, and the manner of disappearance is identical with that which I have just described in the case of the segmentation nucleus. It becomes irregular; radiating channels run off from it into the yolk; the central chamber vanishes, and the channels are visible for an instant longer, and then disappear. The yolk is so opaque that I was not able to see that any part of the vesicle was left behind as a pronucleus, but this is probably the case.

It is useless to speculate at present upon the significance of these highly suggestive changes, but they certainly show that we may hope for very interesting results from the minute histological study of the eggs of marine Lamellibranchs.

In this connection, I may call attention to a point in the history of the "Auerbach's figures." It is not generaly known that these were first figured by Carus, more than fifty years ago, in the egg of a Lamellibranch. His figures of the segmenting egg of Unio (Neue Untersuchungen über die Entwickelungsgeschichte unserer Flussmuschel. Von Dr. J. G. Carus. Nova Acta, 1832, 8, 1), show these structures about as they are represented by Flemming, but he regards them

as the plates of a calcareous shell, and compares the egg to a sea-urchin.

To return to the segmentation; immediately after the large vesicles have disappeared, the egg has the appearance shown in Figure 14. One minute later (Figure 15), the first micromere, *c*, has become nearly spherical, and stands out sharply from the remainder of the egg, and the compound mass, *a* and *b*, of the preceding figures, is again separated into the macromere, *a*, and the second micromere, *b*. In another minute (Figure 16), the formative pole is divided into four micromeres, one of which, *b*, is only slightly marked off from the macromere, while the three others are more distinct. The impossibility of seeing both sides of the egg at once makes it difficult to say just how these four spherules are formed, but it seems most probable that two of them are formed by the division of the first micromere, and two by the division of the second.

In the egg which was figured the nearest spherule bears every indication of an origin by the division of the first micromere, *c*, into two, and other eggs served to show with equal clearness that one of them is also separated off from the second micromere, *b*. Certain irregular forms of segmentation, which will be described later, also appear to sustain this view.

Owing to an unfortunate oversight, the dotted lines which should connect the letters of reference with the parts they refer to were not copied in the drawings from which the photo-electrotypes of Plates II. and III. were made; but I hope that a more careful description will supply a remedy for the accident. Two minutes later, Figure 17, three of the micromeres, the first, *c*, and the two new ones, *d d*, are well defined and prominent; but one of them, the second micromere, *b*, has again begun to become fused with the macromere, *a*. After another interval of three minutes and a half, Figure 18, this micromere has become completely fused with the macromere, to form a compound mass, *a* and *b*, which is almost spherical, and in this a single transparent vesicle has made its appearance. The other three micromeres are even more

sharply separated than at the preceding stage, and a vesicle has made its appearance in each. After two minutes and a half, 19, these three micromeres have flattened down against each other and against the compound mass, so that the egg is once more nearly spherical. This stage may be called the third period of rest.

This figure and the one before it are from the same egg, as indeed are all the figures on this plate except 25, 27 and 28; but after Figure 18 had been sketched, the egg rotated a little, and Figure 19 is a view at right angles to all the preceding ones.

The vesicles are seen to be a little larger than they were a few minutes before, but I did not succeed in seeing them disappear at this stage.

The egg which was figured remained in the condition shown in Figure 19 for thirteen minutes, and during this time it rotated back again into the position which it had occupied at first.

At the end of thirteen minutes the three micromeres *c*, *d*, *d*, again became conspicuous; the compound mass, *a* and *b*, elongated, and a surface depression separated the portion *b* from the portion *a*, and the first micromere, *a*, quickly divided into two, as shown in Figure 20.

By moving the cover-glass, I managed to rotate the eggs a little, and to get a sketch, Figure 21, in the same position as Figure 19. Figure 21 is one minute later than Figure 20, and it will be seen that the second micromere, *b*, and two of the others, have already begun to flatten down and to pass into the resting condition.

From this time on I was not able to keep the egg under constant observation, but examined it at short intervals. A well marked resting period follows the stage shown in Figure 21, but as it presents no new features, it was not figured. Figure 22 is fifteen minutes later, and shows the egg at the fourth period of activity. There are now two more micromeres, which appear to be formed by the two, *c c*, Figure 20, which were produced during the third period of activity by the division of the first, Figure 14, *c*.

The egg is now made up of one large micromere, *a*, at the nutritive pole, and at the formative pole six small, distinct spherules, *cc*, on one side of the polar globule, and one large one, *b*, on the other side; this is flattened, in contact over a large area with the macromere, and is, without doubt, the second micomere of earlier stages.

The history of the later stages shows that the single micromere, *b*, of this stage is anterior to the polar globule, while the group of six is posterior to it. The single macromere occupies what is to become the dorsal surface, and this figure is accordingly a view of the left side. For the sake of brevity, I shall in future use the terms dorsal and ventral, right and left, and anterior and posterior in describing the embryo, and it will be convenient to make this figure a reference mark. The ventral surface is here above, the dorsal below, the left side towards the observer, and the anterior end on the right side of the figure.

Figure 23 is a view of the posterior surface of the same egg twenty-three minutes later. The micromeres which are posterior to the polar globule have now increased in number, and form a cap—the ectoderm—resting upon the macromere. The number of spherules, or ectoderm cells which form this layer, now increases rapidly by the division of large cells into smaller ones, and two couples which have been formed in this way are shown in the figure. The ectoderm is also increased by the separation of new spherules or micromeres from the macromere at the point where this touches the posterior border of the ectoderm. This portion of the ectoderm may therefore be called the growing edge.

Figure 24 is a view of the left side of the same egg five hours and fifteen minutes later. The anterior margin of the macromere is still separated from the polar globule by a single spherule, the second micromere, *b*, but posteriorly and at the sides the layer of ectoderm has grown considerably. At five points on the exposed side there are pairs of small cells, each of which has been formed by the division of a larger one. Figure 25 is another egg in nearly the same stage of development, but it has been copied here in order to show

the separation of a new micromere, *g*, from the macromere, *a*, at the growing edge of the ectoderm.

Figure 26 is a view of the same egg as Figures 22, 23 and 24, but fifty-five minutes later than Figure 24. The ectoderm cells are now much smaller and more numerous, and the macromere is almost covered by them. At the growing edge *g*, a new micromere is separating from the macromere, and there are now a number of small cells on the median line anterior to the polar globule. In dead eggs at this stage a transparent cavity separated the inner surface of the layer of ectoderm from the macromere, but this space does not appear to be normal, and the macromere seems, in living eggs, to be in contact with the outer layer, and there is no indication of a segmentation cavity. In many respects the segmentation of the oyster egg is very similar to that of the egg of Unio, as described by Rabl, but in Unio the segmentation cavity is present at a much earlier stage than this.

From this point on I made no attempt to trace the changes of individual eggs, but made sketches of new stages as I found them. The stages which are figured here are by no means all which were observed and sketched; and I found a number of embryos intermediate between nearly all the stages which were reproduced, so that my series was much more complete than the series of figures.

Figure 27 is a surface view of the left side of an embryo twenty-seven hours after impregnation, and Figure 28 is an optical section of the same embryo. The outline of the body has undergone considerable change, and the longest axis is now the axis which runs from the polar globule to the posterior end, and the vertical axis, which was the longest during the earlier stages, is now the shortest. In a view from above or below the outline is elliptical. The optical section, Figure 28, shows that the macromere is now divided into two large spherules, *en*, which are almost entirely covered by the ectoderm, *e e*, except over a small area on the dorsal surface. The polar globule is now separated from the anterior edge of the ectoderm by four cells, which are smaller than those at the opposite or growing edge. Figure 29, is a view of the

dorsal surface or nutritive pole of a somewhat older egg, showing the two spherules of the endoderm uncovered by the ectoderm. The flattening of the embryo at the ends of the vertical axis, which had made its appearance at the stage shown in Figure 27, has now become more pronounced, and the body is nearly disk-shaped, with its dorsal and ventral surfaces flattened and parallel. The two endoderm cells now divide up, and a short time after the stage last figured they are six in number, as shown in Figure 30, which is a view of the ventral surface; the dark endoderm cells being visible through the more transparent ectoderm. Figure 31 is an optical longitudinal section of a somewhat older embryo, represented with its dorsal surface to the right, and its anterior end above. The flattening of the upper and lower surfaces is well shown in this figure. At about this stage, or a little earlier, the ectoderm and endoderm separate from each other, and a well marked segmentation cavity, or, more properly, a body cavity, is now clearly visible between them. The endoderm has now divided up into a number of large spherules, forming a layer which is pushed in towards the ectoderm, so that the dorsal surface is no longer flat, but saucer-shaped, thus forming a wide, shallow cavity, the primitive digestive cavity, *g*. On the ventral surface the ectoderm cells now carry a few short scattered cilia, and the embryo begins to swim or rotate a little.

It now undergoes considerable change of form, and in a few hours it presents, when seen in a side view, the form shown in Figure 32.

This is a surface view of the left side, and Figure 33 is an optical longitudinal section of the same embryo. This stage is of great importance in the attempt to raise the young from artificially fertilized eggs, for the velum now makes its appearance, and the embryos swim to the surface of the water, where they form a dense layer, which can be siphoned off into a supply of pure sea water, leaving the dead eggs behind. The outline at this stage is very irregular, but perfectly definite and characteristic, although the great activity of the em-

bryo renders this, in the oyster, as in most other molluscs, the most difficult stage to study.

I give three surface views of it (Figures 32, 34 and 35), in order to show the characteristics of the various aspects. Figure 32 is a view of the left side, with the anterior end to the right and the dorsal surface below. Figure 34 is an anterior view of the ventral surface, that is, a view of the upper right hand surface of Figure 32, and Figure 35 is a view of the dorsal surface. In both 34 and 35 the anterior end is below. In the embryo from which these figures were drawn the polar globule was not present, but in other embryos it occupied the centre of the tuft of cilia of the velum, as shown, at a later stage, in 36, so that there can be no doubt that the velum occupies that end of the embryo which is above in Figure 31, and at the right in most of the preceding figures.

Near the centre of the ventral surface—the top of Figure 32—there is a well marked and constant protuberance of the body wall, which occupies the region which, in most molluscan embryos, gives rise to the foot, and which may perhaps be regarded as a rudiment of that organ. In front of this protuberance the anterior end of the body is round, and is occupied by the long cilia of the velum, which form a complete closed circlet. In the centre of the dorsal surface the body is crossed by a deep crescent-shaped furrow, 32, 34 and 35 *g*, which is transverse to the long axis of the body, and which is seen in an optical section, 33 *g*, to be prolonged into the body as the primitive digestive cavity.

Posterior to this the body terminates in a pointed protuberance, 32, 33 and 35 *a*, which is of importance in determining the relation between this and later stages, and which may be called the anal papilla. A comparison of Figure 33 with Figure 31 indicates that the present form of the body has been brought about by the infolding of the edges of the disk-shaped embryo, Figure 30, towards the dorsal surface, in such a way as to carry the endoderm into the centre of the body, thus giving rise to a primitive digestive cavity, with a dorsal blastopore situated in the centre of a crescent-shaped transverse furrow. Rabl has figured a stage in the develop-

ment of Unio (Entwickelungsgeschichte der Malermuschel, Figures 28 to 32), which is very similar to this, both in outline and in internal structure, and Flemming has figured a very similar stage in Anodonta (Entwickelungsgeschichte der Najaden, Taf. II Figure 32), but each of these authors regards the surface where the polar globule is placed as posterior. The published accounts of the transformation of the glochidium into the adult Unio or Anodonta (Ueber die postembryonale Entwickelung unserer Süsswassermuscheln (Anodonta). von Dr. M. Braun in Würzburg. and: Zur Entwickelungsgeschichte der Teich- und Flussmuschel. von Carl Schierholz.) are not sufficiently explicit to decide what the relation between the body of the larva and that of the adult really is, and until some one publishes a satisfactory illustrated account of the transformation, the fact that the velum of the oyster certainly makes its appearance at the point which is occupied by the polar globule must lead us to believe that Flemming and Rabl are in error, and that the region between the letters *a* and *i* of Rabl's Figure 28, is that which is occupied by the velum in the the marine Lamellibranchs, and therefore the anterior.

The free-swimming stage may be reached, under exceptionally favorable circumstances, within two hours after impregnation, but it is not usual for the embryo to attain to this degree of development in less than twenty-four hours, and it may require more than two days to reach it. The duration of this stage also varies greatly, but after from one to twelve hours the embryo will be found to have assumed the form shown in Figure 36, which is the same view as Figure 32. The outline of the body has not undergone much change, and the anterior end is still rounded and carries the velum, while the pointed anal papilla, *a*, occupies the posterior end. The foot-like protuberance on the ventral surface has disappeared, and the blastopore on the dorsal surface has entirely closed, and the ectoderm has become continuous over it, thus leaving the endoderm as a spherical body of cells inside the body cavity. I was not able to discover any central cavity inside this mass, but the cells are so opaque that it would be very difficult to

see a small cavity if one were present, and I do not think there is any reason to believe that the primitive digestive cavity becomes obliterated, although I am certain that this is the fate of its external opening. Before the crescent-shaped transverse groove has entirely disappeared, a small, irregular, transparent body, Figure 36 *s*, makes its appearance at each end of it, and the subsequent history shows that these two bodies are the two valves of the shell, which are entirely separate from each other from the first.

THE RATE OF SEGMENTATION.

Before I go on with the description of the later stages of development, I wish to discuss two or three points in connection with the stages which I have already described; one of these is the rate of segmentation.

As I have already stated, the time record which I have given in connection with the figures is exceptionally slow, and I will now give the intervals between certain stages in the development of other lots of eggs for comparison:

Lot A.—Warm, bright day. Eggs fertilized at 10 A. M.; segmentation commenced between 12 and 1.30 P. M., averaging about 1 P. M., or three hours after fertilization. The stage shown in Figure 26 was reached by most of the eggs between 2 P. M. and 3 P. M., or about five hours after impregnation.

The stage shown in Figure 32 was reached about 4 P. M., and seven hours after fertilization nearly all the embryos were swimming at the surface.

Lot B.—Cool day. Eggs fertilized at 10.30 A. M. About half of the eggs developed, and segmentation commenced between 12.30 and 2 P. M., or about three hours after fertilization. The stage shown in Figure 26 was reached in about twelve hours, and the stage shown in Figure 32 was reached by a very few eggs during the second day, but at the end of the second day all were dead.

Lot C.—Very cold; hail and rain. The eggs from several ripe females were fertilized, but no changes followed, and all the eggs soon decayed.

Another lot of embryos, which were about three days old, and in the stage shown in Plate III, Figure 38, also died.

Lot D.—Day quite cold. The eggs from three females were very carefully fertilized with a mixture of the semen from three males at 10 A. M. About one in one hundred commenced segmentation between 1 and 6 P. M., and developed very slowly. The next day all were dead. As the eggs were perfectly ripe, and became covered with active spermatozoa, their failure to develop must have been due to the low temperature.

Lot E.—Quite cool in the morning; warm and sultry in the afternoon. Eggs fertilized at noon, and segmentation commenced in about two hours. At 7.30 P. M. about half of them had finished segmentation, and at 11.15 P. M. most of them were in the stage shown in Figure 32. On the fourth day most of them were doing well, and had reached the stage shown in Figure 42, when a fall in the temperature killed all of them.

Lot F.—Rather warm. Eggs fertilized at 6 P. M., and the next morning at 5, or eleven hours after fertilization, some were in the stage 32, and some in the stages 36 and 37.

Lot G.—Day quite warm. Eggs fertilized at 8 P. M. At 10.15 P. M., or a little more than two hours after fertilization, nearly all of them were in the early stages of segmentation, and at 5 A. M., or nine hours after fertilization, they were in the stage shown in Figure 37, and in forty-eight hours they were in the stage 42.

Lot H.—Very hot day. Segmentation was completed two hours after fertilization, and in two hours and a half the embryos were in the stage 32, and in forty-eight hours in the stage shown in 43.

I was so far from the water during my investigations that I was not able to make any observations upon the temperature of the oyster beds during the spawning season, but the cases

which I have selected above show the dependence of the young upon continuous warm weather.

The past spring and summer were unusually cool, and it was not until the middle of July that the weather was warm for more than three or four days in succession, and my failure to find any floating embryos in the open ocean may be due to the fact that they were killed by the cold as fast as the eggs were laid. After the middle of July I found a few embryo at the surface of the water of the Sound.

EXCEPTIONS TO THE NORMAL METHOD OF SEGMENTATION.

The method of segmentation, as I have described it, is the normal method, and is followed exactly by a very large proportion of the eggs—by more than 90 per cent. of them, I should think; but a few eggs in every lot present considerable variation, especially in the earlier stages.

Plate X, Figures 54 to 62, shows one of the most common variations. If a number of eggs be carefully watched during the early stages a few will be found to reach the stage shown in Figure 13, Plate I, more directly than the ordinary eggs, without going through the process of forming the second micromere *b*, of Plate I, and then obliterating it. Figure 54 is an egg two hours and seven minutes after fertilization, and in the stage shown in Figure 4. Two minutes later it had assumed the form shown in Figure 55, which is very similar to Figure 5, except that the three lobes of the trefoil are less sharply separated. Two minutes later it had assumed the form shown in Figure 56, and one minute later the form shown in Figure 57. As shown by these figures, the second micromere does not become distinct, as in Figure 6, but the faint indication of it shown in Figure 55 quickly disappears, and the subsequent changes result in the separation of the egg into two masses, instead of three. Figure 58 is forty-five seconds later than Figure 57, and Figure 59 four minutes and fifteen seconds later. A single furrow now extends nearly across the egg, from the polar globule, and divides it into two nearly separated portions—a small one and a large one. In

one minute and a half the two were entirely separated (Figure 60), and in two minutes and fifteen seconds more (Figure 61) each part was prominent and rounded, and in five minutes more (Figure 62) they had again approached each other, and assumed the form of Figure 13. This is the variation which is most frequently met with, and it is plainly a simplification of the normal method, by which the result of the first period of activity is reached more directly. In another variation, which is met with much less frequently, the second period of rest is entirely left out, and the stage shown in Figure 18 is reached directly, as shown in Figures 63 to 66. In this case the egg passes through the stages 1, 2, 3 and 4, of Plate I, but when it assumes the trefoil form of Figure 5, a second plane of cleavage, passing through the axis of the polar globule, divides each micromere into two, as shown in Figure 63, in side view, and in 64, viewed from the formation pole.

Three of these spherules remain distinct, but in a few minutes one of them, which appears to correspond to the second micromere of the normal method of segmentation, becomes fused with the macromere, as shown in Figure 65, which corresponds to Figure 16 of the normally segmenting egg. A few minutes later it assumes the form shown in Figure 66, which is clearly the same as Figure 18. Besides these two variations, which occur quite frequently, and are sufficiently regular to demand especial notice, there are occasional irregularities, such as are always found, when a number of eggs are carefully compared, but these do not call for minute description.

THE SIGNIFICANCE OF THE SEGMENTATION OF THE OYSTER EGGS.

Our information regarding the early stages in the development of Lamellibranchs is very scanty indeed, but so far as it goes it indicates that the process of segmentation, as I have described it, is, with slight modifications, common to the whole class.

Lovén's memoir (Bidrag till Kännedommen om Utvecklingen af Mollusca Acephala Lamellibranchiata. Af S. Lovén.

kongl. Vetenskaps-Akademiens Handlinger. Stockh. 1848), contains nearly all the present knowledge of the process of segmentation in the marine Lamellibranchs. I have not the paper before me as I write, and my notes upon it, which were made several years ago, do not contain any figures, so I am not able to make a minute comparison, but the figures which he gives of the segmenting eggs of Crenella and Cardium are essentially like the same stages in the development of the oyster egg, and show that in these two genera the egg divides into a single macromere situated at the nutritive pole, and a number of smaller micromeres situated at the formative pole, and that the macromere is gradually surrounded by a layer of ectoderm cells, which are formed in part by the division of the micromere and in part by the separation of new micromeres from the macromere.

According to the short abstract which Brobetsky (Studien über die Embryonale Entwickelung der Gasteropoden, von Dr. N. Brobetsky aus Kiew. Arch. f. Mik. Anat. 1870, pp. 95—Taf. viii–xiii) gives of Lovén's observations upon the segmentation of the egg of Crenella, p. 104, the resemblance to the oyster does not stop here, but extends to more minute details. The egg divides, as it does in the oyster, into a first and a second micromere, and a macromere which is more transparent than the micromeres. After these three spherules have become distinct, one of the micromeres fuses with the macromere, and all traces of it disappear for a time. The other then flattens down upon the compound mass, and the egg assumes the condition shown in Figure 13. Soon both the first and the second micromeres again become prominent, and then divide, so that there are now four micromeres at one pole of the egg and one larger macromere at the other. One of the four now fuses with the macromere again precisely as it does in the oyster, and a stage like my Figure 19 is reached. As in the oyster, Lovén notices the alternation of periods of rest and activity for some time longer, and the agreement with the oyster appears to be most complete.

Our knowledge of the early stages in the development of the

fresh water Lamellibranchs also shows a great similarity between them and the oyster.

Flemming has given a very minute account of the segmentation of the egg of Anodonta (Studien in der Entwickelungsgeschichte der Najaden, von Walther Flemming in Prag. mit 4 Tafeln. Aus den lxxi. Bande der Sitzb. der k. Akad. der Wissensch. III Abth. Febr. Heft. 1875. Sitzung am 4. Februar, 1875), and his account of the process (pp. 38–58, and his figures, Taf. II. Figures 1–20), show that the segmentation is much like that of the oyster, except that the segmentation cavity makes its appearance very early.

The segmentation of the egg of the Anodonta differs from that of the oyster egg in a number of minute details, but not so much so as to obscure the fundamental similarity. Flemming's Figure 6, of Plate II, obviously represents the same stage as my Figure 13; his Figure 11 is the same as my Figure 19; his Figure 13 the same as my Figure 22; his Figure 17 the same as my Figure 26; his Figure 18 the same as my Figure 28, and his Figure 23 the same as my Figure 32. The polar globules are shown in most of his figures, and prove that, as in the oyster, the growing edge of the layer of ectoderm is at the point which is farthest from these bodies.

The early stages in the development of Unio have been figured and described at length by Rabl. (Ueber die Entwickelungsgeschichte die Malermuschel. Eine Anwendung der Keimblätter—Theorie auf die Lamellibranchiaten, von Carl Rabl, Jenaische Zeitschr, X, 1876, 310–395; Taf. X–XII), and his account shows a still closer agreement with the oyster than is presented by Anodonta.

The segmentation cavity of Unio makes its appearance very early, but in other respects there are few differences between his account and my own, except that I have not found in the oyster the two large cells which he says become pushed into the segmentation cavity of Unio, and give rise to the mesoderm. In a paper which is now in press, on the formation of the digestive tract in the fresh-water Pulmonates, I have been compelled to call attention to the fact that certain figures in an earlier paper by Rabl, on the development of

Pulmonates, are imaginary and unlike anything in nature, and I therefore take pleasure in stating here that my own work upon the oyster tends to show the perfect accuracy of the observations in the present paper, not only so far as the early stages are concerned, but also as regards the later history of the embryo.

Figure 7, Plate X, of the egg of Unio is clearly the same as my Figure 13; Figure 10 is almost identical with 19 of the oyster; Figure 11–14 are very similar to 20–23 of the oyster; Figure 15 differs from 26 of the oyster only in the presence of a segmentation cavity; 17 and 18 are the same as 27 and 28 of the oyster, except that they are not flattened vertically, and his figures 28 and 30 are essentially the same as my 32 and 38.

I have already shown that the stage 13 of the oyster egg, which is usually reached by passage through a number of intermediate stages, and by the formation and obliteration of a third spherule, may be reached by a more direct process, which is exceptional in the case of the oyster. It is interesting to notice that Flemming and Rabl agree that the indirect form of segmentation which is normal in the oyster, is wanting in Anodonta and Unio, and that this stage is reached directly in a manner which is only occasionally met with in the oyster.

There can be no doubt, that in Anodonta at least, the trefoil stage is really wanting, and has not simply been overlooked, for Flemming actually watched and has figured the change of the spherical unsegmented egg into the form shown in his Figure 6.

In addition to the observations above referred to, we have a number of papers which deal with the development of various species of Cycladidæ, and contain some observations upon the early stages, but no one has succeeded in getting anything like a complete series of observations, and those which are recorded are not at all in harmony with each other. In his "Contributions to the Developmental History of the Mollusca, No. I, The Early Development of Pisidium pusillum," (Phil. Trans. 1875, vol. 165, part I), Lankester gives a

short description, pp. 2 and 3, and a few figures, Plate I, Figures 4, 5, 6, 7, 8, 16 and 17, of the process of segmentation. His observations are very fragmentary and unsatisfactory, but they would seem to indicate that the segmentation is total and regular, and not at all like that of the oyster.

Ganin reaches a similar conclusion, and says (Beitrag zur Lehre von den embryonalen Blätter bei den Mollusken. Abst. in Hoffman u. Schwalbe's Jahresberichte. 1. 1872), that in Cyclas the segmentation is total and regular, and results in the formation of a spherical layer of similar cells around a central cavity.

Von Jhering and Rabl, on the other hand, give observations which indicate that the segmentation is, on the whole, like that of the oyster.

Von Jhering says (Ueber die Ontogenie von Cyclas und die Homologie der Keimblätter bei den Mollusken, Zeit. f. Wiss. Zool. 1876- xxvii), that although he did not succeed in getting as complete a series of forms as Flemming has figured in Anodonta, the stages which he has found show that the process of segmentation takes place about as it does in Anodonta, and Rabl says, p. 340, that he has observed two stages in the segmentation of Cyclas, and that the mode of segmentation is the same here as in Unio. In Taf. XII, Fig. 58, he shows one of these stages, which differs from one of the later stages of the segmentation of the oyster egg only in the presence of a large segmentation cavity.

These references, which cover the whole field of our exact knowledge of lamellibranch segmentation, show that probably in the Cycladidæ, and certainly in Unio, Anodonta, Crenella and Cardium, we have nearly the same mode of segmentation as in the oyster; but that the normal method of oyster segmentation is indirect, and may be simplified occasionally in the oyster, and normally in Unio and Anodonta, by the omission of many of the stages of the process and the retention of those only which lie in the direct line of development. I have described this process in the oyster with great minuteness, and perhaps with tedious exactness, since I believe that it

is of phylogenetic significance, and indicates the origin of the Class Lamellibranchs.

The distinctive characteristics of this form of segmentation are the very small size of the eggs; the appearance of bilateral symmetry with the first cleavage, and the indication at the same time of the anterior and posterior ends and right and left sides and dorsal and ventral surfaces of the adult; the separation of the egg at the beginning of segmentation into a germinative portion, and a portion which is morphologically comparable, during the process of segmentation, to a food yolk, although it is less granular, both in the oyster and in Crenella, than the germinative portion, and at a later stage undergoes segmentation, and forms the wall of the digestive cavity, so that it has none of the physiological characteristics of a food-yolk; and the fact that many of the stages in the process of segmentation have no functional importance and may be suppressed. Outside the Lamellibranchs, whenever we have very small simple eggs among the Mollusca, the embryo is radially symmetrical around a central axis, which passes through the polar globules, and it presents, during the process of segmentation, few points of resemblance to the egg of the oyster at the same period. In support of this statement, I may refer to Lankester's figures of the eggs of Nudibranchs and Opisthobranchs (Developmental History of the Mollusca, Plates 5 and 9), to Fol's figures of the eggs of Pteropods and Heteropods (Etudes sur dévelopment des Mollusques. Arch. d. Zool. exp. et gen. 1875), to my own observations on the segmentation of the Pulmonate egg (Studies from the Biological Laboratory of the Johns Hopkins University, 1879), and to Bütschli's and Lankester's accounts of the segmentation of the egg of Paludina, ("Entwickelungsgeschichte von Paludina vivipara." Zeit. f. Wiss. Zool. 1877, and "On the Coincidence of the Blastopore and Anus in Paludina vivipara." Quart. Mic. Journ. 1876.)

Rabl has briefly discussed the relation of the bilaterally symmetrical, irregular segmentation of the lamellibranchiate egg, to the regular axially symmetrical segmentation of the egg in most Gasteropods (Entwickelungsgeschichte der Mal-

ermuschel, pp. 338–345), and concludes that the first is an adaptational modification of the last, which gives the Lamellibranch an advantage in the struggle for existence, and which has therefore been preserved by natural selection. He says, p. 244: "Die inequale Furchung dem sich entwickelnden Embryo einen Vortheil gewährt, und dass dieser Vortheil um so grösser ist, je frühzeitiger sich eine Ungleichheit in den Furchungsproducten bemerkbar macht."

I think, however, that all the evidence which I have given points towards the conclusion that the peculiar segmentation of the Lamellibranchs is due rather to the retention of characteristics which were adapted to some past condition of things than to direct adaptation to the present conditions of life; and we must therefore look for its origin somewhere else than in the regular radially symmetrical segmentation of the small simple eggs of the Pulmonates. I think that a comparison of my account and figures with the figures and description given by Brobetsky and myself of the segmentation of the egg in those Prosobranchs where the eggs are few in number, large, and contain a large food-yolk which is of physiological importance, will fully support the conclusion that we have here the ancestral form of segmentation, which is retained by the small eggs of the Lamellibranchs.

In a paper entitled "Preliminary Observations on the Development of the Marine Prosobranchiate Gasteropods," (Chesapeake Zoological Laboratory, Scientific Results of the Session of 1878, p. 121), I have given outline figures of a few of the stages in the segmentation of the egg of Urosalpinx, Plate 8, Figures 1, 2, 3, 4, 9 and 10, and a reference to these figures will show that there is considerable resemblance between this and the oyster egg. A few small transparent micromeres separate off from the surface of the large food yolk, which occupies the nutritive pole of the egg, and gives rise to a blastoderm which spreads over the surface of the food-yolk; growing at one edge, partly by the division of the micromeres and partly by separation of new ones from the yolk.

From the beginning of segmentation the egg is bilaterally symmetrical, and the general resemblance to the oyster egg is

easily seen, although it is not at all complete or minute, but according to Brobetsky (Studien über die embryonale Entwickelung der Gasteropoden, von Dr. N. Brobetsky in Kiew. Arch. f. Mic. Anat. xiii. 1877, pp. 95–170. Taf. viii–xiii), the early stages in the development of Nassa are almost exactly the same as those of the oyster. The egg of Nassa has a large functional food-yolk, and the blastoderm which surrounds it is not simply an ectoderm, since it gives rise to all the germ layers; but before the differentation of the spherules at the formative pole has made its appearance, segmentation takes place exactly as it does in the oyster, and the first ten figures of Brobetsky's first plate might have been used, without the least change, to represent the stages of the oyster egg which I have given in my first nineteen figures. I hope to publish soon a short paper, illustrated by a comparative table of outline drawings of the segmenting eggs of various Molluscs, in order to illustrate my conception of their significance, but at present I must refer to the various original papers. A reference to Brobetsky's account and figures will show that his Figure 1, Taf. VIII, is almost exactly like my Figure 4; his Figure 2 like my Figure 5; his Figure 3 like my Figure 7; that his Figure 4 shows the change illustrated more at length in my Figures 8, 9, 10 and 11; that his Figure 5, A and B, shows the same stage as my Figure 13; that his Figure 6 is the stage 15 of the oyster; his Figure 7 the stage 16; and that his Figures 8, A and B, are the same as my Figures 18 and 19. The sections of these stages which Brobetsky gives in Plate IX, indicate that the early appearance of bilateral symmetry in Nassa and Urosalpinx is a condition of things which has been brought about by the presence of a large food-yolk, which does not undergo segmentation, and this conclusion is confirmed by a comparison with Brobetsky's account of the development of Natica and Fusus, where a true food-yolk is lacking, and the embryo is radially symmetrical during the early stages.

The facts which I have given in regard to the oyster show that the peculiar early stages of segmentation are of no func-

tional importance, since they may be omitted occasionally in the oyster, and normally in Unio and Anodonta. In Nassa we find them again, but they are here associated with the presence of a food-yolk, and I think we are, therefore, justified in concluding that the one-sided, bilaterally symmetrical segmentation which there is occasion to regard as characteristic of the Lamellibranchs, indicates that the Lamellibranchs are the descendants of an ancestral form, in which the eggs were few, large and provided with a food-yolk; that this has been lost, as the eggs became small and numerous, but that the peculiar form of segmentation which was then necessary has been retained perfectly by the oyster, and incompletely by other Lamellibranchs.

In a paper which was printed several years ago, (The Affinity of the Mollusca and Molluscoida, Proc. Boston Soc. Nat. Hist. XVIII, Feb. 2, 1876, pp. 225–235), I called attention to a number of reasons for holding the opinion that the Lamellibranchs must be regarded as a side branch from the main stem, of which the Gasteropods are a much more direct continuation, and that all attempts to trace the phylogeny of the higher Mollusca through the Lamellibranchs to lower invertebrates are erroneous and useless; that the highly specialized "veliger" of the marine Prosobranchs is to be regarded as the proto-mollusc, and that the Gasteropods are descended from this with less modification than the Lamellibranchs. The growth of our knowledge of the invertebrates has furnished us with much more material for comparative study than was available at the time this paper was written, and seems to indicate very clearly that the ciliated embryos of the Echinoderms, Gephyreans, Annelids, Polyzoa, Brachiopods, Rotifera, Molluscs and other invertebrates are, all of them, modifications of a common ancestral type, and that the origin of these great groups is indicated by their embryology.

At the same time the careful comparison of adult animals has directed attention to the fact that, in many cases, those groups in which the structure of a type is reduced to its simplest expression, are not ancestral, but degraded, forms. In

such forms as the Lernæans and Entoconcha the degradation is due to actual parasitism, but degradation may be effected by any circumstances which diminish the complexity of the environment and thus render a simplification of structure advantageous; and the view that the characteristics which are most distinctive of the Lamellibranchs have been produced as adaptations to their sedentary life, and that their remote ancestors were similar to those of the higher molluscs, is supported by ample analogy.

It is clear that as an animal becomes adapted to a sedentary life its diffusion must be provided for by an increase in the number of eggs or embryos, and we can easily see that, if the ancestors of the Lamellibranchs were animals which laid only a few large eggs, the gradual acquisition of a sedentary habit would demand a decrease in the size of the eggs, in order to permit an increase in their number.

The evidence which the oyster egg furnishes to show that it was at one time provided with a food-yolk, which has been lost, therefore confirms the view that the Lamellibranchs are a degraded or simplified group.

I take the opportunity, while correcting the proofs of this paper, to call attention to a highly interesting discussion of a kindred subject, which is contained in an elaborate paper, by Rabl, on the development of Planorbis, in the last number of the Morphologisches Jahrbuch, which reached me after this paper was written.

Rabl gives a comparative table of figures, in part original and in part selected, of the early stages in the segmentation of the eggs of a number of Gasteropods, Heteropods and Pteropods, and shows that there is a complete series of forms between the radially symmetrical segmentation of the Planorbis egg, and the egg of Nassa.

His series of figures fully proves his conclusion that the peculiar segmentation of Nassa has been brought about by the gradual localization of a specialized food-yolk, and I think all embryologists will agree with him in holding that his facts show the fundamental similarity in plan of segmentation among the Gasteropods and Pteropods.

Von Jehring's attempt to show that the early stages in the development of Gasteropods differ fundamentally according as they belong to one or the other of the two *phyla* between which he proposes to distribute them, is thus shown to be absolutely without a basis of fact.

In a foot-note to his paper Rabl says that this similarity of ground-plan does not extend to the Lamellibranchs, but the embryology of the oyster shows that it does.

In the Lamellibranch with which he is most familiar, Unio, the process of segmentation is greatly abridged, and its true significance is only seen when it is compared with that of the oyster. This comparison shows that the eggs of Lamellibranchs have passed through a change which is exactly the reverse of the one which Rabl has traced, and the peculiar interest of his paper lies in the fact that while he was tracing the process by which the food-yolk was acquired, I was engaged in tracing the process by which it has been lost, and that the form with which his series ends is the one with which my series begins.

It hardly seems necessary for me to say that I do not wish to be understood to hold that the Lamellibranchs are the descendants of Nassa, but simply that their ancestors laid eggs like the eggs of Nassa.

THE FORMATION OF THE DIGESTIVE TRACT.

At the stage shown in Figures 32 and 33, the primitive digestive tract opens by a wide blastopore, which is situated upon what is to become the dorsal surface; and the outline of the body in front of it is rounded and carries the velum, while behind it the outline is angular and pointed. At the stage shown in Figure 36, the outline of the body is nearly the same, and the external changes are so slight that the side which is below in this figure is at once seen to be the same as that which is below in Figure 32. This surface is still marked by a transverse groove, but the blastopore has closed up completely, and one valve of the shell has made its appearance at each end of the groove. Posterior to the groove the papilla,

a, runs backwards and downwards, and in front of it the outline of the body is rounded and bears the velum. The time when the valves of the shell make their appearance varies slightly, but I have seen them when the transverse groove was as well marked as it is in Figure 35, and this fact, as well as the similarity in the outline of Figures 32 and 36, does not seem to leave room to doubt that the shell occupies the position of the blastopore. At the stage shown in Figure 36, the endoderm is a pretty compact mass, separated, around its entire circumference from the body wall, and with no traces of a central cavity, although it is perfectly possible that a small cavity may be present.

Figure 37 is an embryo a few hours older, viewed from the right side, with its dorsal surface uppermost. The shell *s* is much larger than it was at the preceding stage, and is usually quite irregular in outline, although a few embryos were found at this as well as at the stage 36, in which each valve was perfectly regular in outline, pear-shaped, and placed with the narrow end nearest the middle line. A little posterior to the shell is the anal papilla *a*, which now carries a few short, stiff cilia or setae. The relative positions of the shell, anal papilla and velum in the preceding stages seem to show with satisfactory clearness that the side which is uppermost in this figure is that which is below in most of the preceding figures, and which I have called dorsal.

The digestive tract is now much larger than at the preceding stage, and its centre is occupied by a distinct cavity, the wall of which is ciliated. At a point nearly opposite the shell this cavity opens externally by a new opening, *m*, and small particles of food now find their way into the central cavity, where they are kept in rotation by the cilia. At this stage the margins of the opening *m* can be protruded so as to form a projecting sucking disk, by which the embryos adhere to each other and to foreign bodies.

The series of stages which I have figured seems to show that this new opening is almost directly opposite the position which the blastopore occupied at stage 32.

In from two to four days after fertilization, the embryo assumes the form shown in Figure 38, which is a view of the right side. The shell is now large and regular in outline, and covers nearly half of the surface of the body. The digestive tract now has two external openings, *m* and *an*, which are close together on the ventral surface of the body. In a side view, Figures 38 and 39, it was almost impossible to say whether either or both of these communicate with the digestive cavity, but embryos were frequently found with the two valves of the shell stretched out into the same plane, and with the body pulled up and flattened against the shell, and in a dorsal or ventral view of such an embryo, it was easy to see that both openings do communicate with the central cavity. Figure 41 is a dorsal view of an embryo at the same stage as Figure 38, but with its valves extended.

The stomach is seen through the shell, and when the animal is in this position, is pear-shaped, with the broad end of the pear in front and the narrow portion on the median line behind, and the anus, *a*, could be seen at the tip of the stalk, while the mouth, *mo*, is in the centre of the broad anterior end.

It will be seen that these openings are much farther apart when the body is stretched by the opening of the valves than when these are more inclined to each other, as they are in the side view, Figure 38. The anterior opening, or mouth, 38, 39 and 42, *mo*, is not, at this stage, a simple tube, but a large, nearly spherical pouch, which is capable of protrusion from the surface of the body. I was not able to determine whether these two openings were or were not formed by the division of the single opening shown at the stage 37, and therefore cannot say whether the opening in this figure is the mouth, the anus, or both.

In an embryo four or five days old, Figures 42 and 44, the digestive tract has increased considerably in size, and the posterior portion is much smaller than the anterior part, and forms a tubular intestine, *i*. At the stage shown in Figure 44 the lateral walls of the stomach begin to fold out, so as to

form a pair of pouches or diverticula, the halves of the liver, l_r in the walls of which numerous highly refractive oil-globules make their appearance.

Our knowledge of the digestive tract in the Mollusca is at present in the greatest confusion; and in most molluscs the difficulties of observation are so great at the time when the most important changes take place, that it is almost impossible to obtain any perfectly satisfactory results.

The oyster presents exceptionally favorable conditions for investigating this question, and the observations above described seem to show conclusively—

1st. That there is an invaginate gastrula stage.

2d. That the blastopore closes completely, leaving the digestive tract without an opening.

3d. That the shell appears at the point which the blastopore previously occupied.

4th. That first one and then two openings from the outer surface into the digestive tract make their appearance almost directly opposite the position of the blastopore, and that one of them becomes the mouth and one the anus.

The most thorough and satisfactory account of the origin of the digestive tract in Lamellibranchs is that of Rabl (Entwickelung der Malermuschel), and the process, as he describes it, is like what I have observed in the oyster, so far as all the leading points are concerned. At the close of segmentation the single large macromere of Unio divides into a number of large cells, which cover the dorsal surface of the embryo, Taf. X, Fig. 23. They then push into the body cavity, so as to form a primitive digestive cavity, which opens by a dorsal blastopore. Taf, XI, Fig. 28.

The shell now appears, and covers up the dorsal surface, Taf. XI, Fig. 34, and the blastopore closes up, thus leaving the digestive tract without any opening. Taf. XII, Fig. 54.

A new opening is now formed by the invagination of the integument, at a point on the ventral surface, Figure 54, which is at some distance from the blastopore, but not directly opposite it, as in the oyster.

Flemming was not able to obtain much information regarding the history of the digestive tract, but as he has conscienciously adhered, in his description, (Entwickelungsgeschichte der Najaden), to what he has been able to actually see, his account agrees with Rabl's so far as it goes, and there is every reason to believe that the process is the same in Unio and Anodonta and the oyster. Flemming shows that in Anodonta the single large macromere divides up into a layer of large cells which occupy the dorsal surface of the body, and subsequently become covered by the shell, but he was not able to trace their future history.

The various accounts of the origin of the digestive tract in the Cycladidae are so very contradictory and irreconcilable that it does not seem worth while to try to get at the truth by comparing them, without making any original observations, and Rabl's paper and my own fairly represent the present state of our knowledge of the origin of the digestive tract in Lamellibranchs. The difficulties of observation are so great that the observations of an investigator who did not direct especial attention to the subject are not likely to afford information of much value, and at the time Lovén's paper was written the problems of invertebrate embryology were so different from those of the present day that no conclusions regarding the history of the digestive tract can be drawn from his figures.

THE DEVELOPMENT OF THE OYSTER AND THE GASTRULA THEORY.

Salensky has given (Bemerkungen über Hæckel's Gastraea—Theorie. Arch. f. Naturgeschichte, 1874), a very brief account of the origin of the digestive tract in the oyster, illustrated by three figures. He says, p. 150, "das erste Stadium der Entwickelung ein Embryo ist, welcher aus zwei Schichten besteht, und in Inneren keine Höhle trägt," Figure 1, Taf. V, "dass sich dann verschiedene äussere Organe und eine Mundeinstülpung bilden, und schliesslich im Inneren des Entoderms eine Darmhöhle entsteht," Figures 2 and 3.

After a very exhaustive and able review of the facts in embryology with which we were at that time acquainted, he con-

cludes that the embryology of the oyster and that of other Metazoa proves that the starting point in their development is not the gastrula stage, but a "planula" stage, in which the embryo consists of two layers of cells without a central cavity; that this planula stage may be so modified as to give rise to a "blastula" stage, in which a double layer of cells surrounds a central cavity without an external opening; that while the blastula is to be regarded as a modification of the planula, the planula stage may be omitted, and the embryo may at once assume the blastula form; that the formation of the stomach-cavity is a later and secondary occurrence in the history of development, that it takes place at different stages in different animals, and has no place in a conception of the general plan of development; that either the planula or the blastula may complete its development by passing through a "gastrula" stage, which, however, is not the primitive condition of the embryo, but a secondary modification of later formation, which may or may not present itself; that the "gastrula" stage of development is not the common starting point for all Metazoa; and that the hypothetical "Gastraea" cannot be regarded as the ancestral form from which the higher groups have been derived, pp. 159–173.

A comparison of his figures of the oyster embryo with my own shows that his Figure 1 represents a stage between my Figures 36 and 37; his Figure 2 one at the same stage as my Figure 38, and his Figure 3 one at the stage as my Figure 45.

He is correct in the statement that the embryo shown in his first figure consists of a central mass of endoderm which is entirely surrounded by the ectoderm, and in which no cavity can be seen; and that the mouth and anus are formed and the stomach-cavity becomes visible at a late stage, after the shell and velum have appeared.

My own observations, and those of Rabl on Unio, show, however, that the so-called "planula" of the oyster is preceded by a true invaginate gastrula stage, and that, so far as the development hypothesis above quoted rests upon the embryology of the oyster, it is directly opposed to the facts.

Salensky's hypothesis seems to be almost identical with Ray Lankester's so-called "planula theory," published the year before (On the Primitive Cell-layers of the Embryo as a Basis of Genealogical Classification of Animals. Ann. and Mag. Nat. Hist., May, 1873: and, Notes on Embryology and Classification, for the use of Students. London: 1877), the essential difference between which and Haeckel's gastrula theory is the conception of the gastrula as a secondary modification of the planula. The fact that in Unio and in the oyster a planula is formed by the modification of a gastrula, would seem, so far as it goes, to be as adverse to Lankester's hypothesis as it is to Salensky's. Von Jhering's view, that the primitive embryonic form among the Mollusca is not a gastrula, but a "lepospharera," does not seem to involve any new conception, for according to his definition (Ueber die Ontogenie von Cyclas, und die Homologie die keimblätter bei den Mollusken, von Dr. Hermann von Jhering. Zeitschr. f. Wiss. Zool. xxiv. Marz. 1876, pp. 414–438), his lepospharera is the same as Lankester's and Salensky's planula. "Die Lepospharera wird also aus zwei concentrischen Zellschichten gebildet von denen die äussere oder das primäre Ectoderm die innere oder das primäre Endoderm umgiebt, wie die Schalle einer Nuss den Kern einschliesst. Der bleibende Mund entsteht im Ectoderm der Lepospharera, der Oesophagus entweder vom Munde aus, wie bei den Gasteropoden, oder vom primäre Endoderm aus, wie bei den Lamellibranchien," p. 429.

The facts in the development of the oyster are thus seen to be opposed to the only consistent and probable hypothesis which has ever been proposed in the place of the gastrula theory: the hypothesis that the planula is the primitive embryonic form, of which the gastrula is a specialized modification; but it must not be concluded that since the embryology of the Mollusca is opposed to the alternative hypothesis it therefore tends to support the hypothesis that the gastrula stage has a phylogenetic significance, and shows the descent of the Mollusca from an ancestral gastraea.

The most satisfactory and trustworthy papers which we possess upon the development of the Mollusca show that

while there is in many cases a true gastrula stage, its orifice bears no constant relation to the definitive mouth and anus.

There does not seem to be any valid reason for disputing Fol's statement (Etudes sur le développement des Mollusques, I. Ptéropodes, arch. d. Zool. exp. et gen. IV, 1875), that on the Pteropods the orifice of invagination persists and becomes the definitive mouth. We have the testimony of both Lankester and Bütschli ("On the Invaginate Planula or Diploblastic phase of Paludina vivipara," by E. Ray Lankester. Quart. Jour. Mic. Sc. XV, 1875; and "On the Coincidence of the Blastopore and Anus in Paludina vivipara," by E. Ray Lankester. Quart. Journ. Mic. Sc. XVI, 1876, and "Entwickelungsgeschichtliche Beiträge. I. Jur Entwickelungsgeschichte von Paludina vivipara, von O. Bütschli, zeitsche. f. Wiss. Zool, XXIX), to prove that in Paludina the orifice of invagination persists and becomes the anus.

In the oyster the orifice of invagination closes up, and forms the shell and in the Squid it is perfectly certain that the point where the blastoderm folds in over the food-yolk has no connection with either the mouth, the anus or the shell-gland.

It is not necessary to extend the above list by references to observers who have given still different accounts. There are fine grounds for disputing the correctness of many of these papers, but I do not think the present state of our knowledge gives us any reason for doubting the conclusions of Fol, Lankester and Bütschli; my own observations on the oyster are confirmed by Rabl, and in a future paper I hope to show that the Squid is such a favorable subject for study that there is no chance for error in the statement which I have given above, and we may conclude that the present condition of embryology fully justifies Lankester's statement that in the Mollusca there is no necessary connection between the blastopore and either the mouth or the anus.

Now there cannot be the least doubt that the molluscan mouth is the same opening in all the classes, and that the anus is also homologous throughout the whole group.

It is perfectly possible that the mouth and anus might exchange functions during the evolution of a group of animals, or that one or both might be replaced by new openings, and Semper (Stammverwandschaft der wirbelthiere und wirbellosen), und Dohrn (Ursprung wiebelthiere), have given very convincing evidence that such a change has actually taken place in the vertebrate mouth during the evolution of these animals, but there is not the least reason for believing that anything of the kind has taken place during the evolution of the classes of Molluscs, but the whole of the evidence furnished by Comparative Anatomy and Embryology tends to show that nothing of the kind has taken place, but that the mouth and anus, and the shell-gland as well, can be homologized perfectly in all the classes of true Molluscs, and that they are not only homologous with each other, but must be perfectly homologous also with similar structures in the ancestral form of which the classes of Molluscs are modifications.

If there has been a time when all the classes of Molluscs were represented by a single form, a *proto mollusc*, with a mouth, an anus and a shell-gland, which were homologous with the similar structures in all its descendants, this ancestral form must have been much later than the "gastræa," and if it was produced by evolution from a gastræa at all, it is plain that the mouths, anuses and shell-glands of all the classes of Molluscs must bear the same relation to the organs and openings of this ancestor—the "gastræa."

The fact that the blastopore of the gastrula stage does not, according to our best information, bear any such constant relation to the body of the adult, therefore opposes the conclusion that this stage has a phylogenative significance, and we are fully warranted in the statement that the present state of our knowledge forbids the acceptance of the gastrula theory as an established generalization of scientific value.

I do not think, however, that we are justified in going farther, and concluding the theory is disproved by the facts of molluscan development.

The early stages of the development of the different classes of vertebrates presents, at first sight, few points in common,

yet Balfour has shown (A Monograph on the Development of the Elasmobranch Fishes, by E. M. Balfour, M. A. London: 1878), that the types of the early development of all vertebrate animals can be easily derived from that of the typical gastrula.

The general occurrence of a gastrula stage in so many widely separated animals is certainly the most pronounced feature in embryology, and it is possible that a more complete acquaintance with the development and phylogeny of the Mollusca may show that the facts held do not, in reality, oppose the view that it is an ancestral form, and the conclusion which the facts seem to justify is not that the gastrula theory is proved or disapproved, but that our acquaintance with the facts must be very much greater than it is at present before we shall be prepared to establish any general hypothesis as to the ancestry of the Metazoa.

THE SHELL.

The two valves of the shell of the oyster originate separately, as I have already stated, while in some other Lamellibranchs the separation of the valves is brought about at a later stage of development, by the division of a continuous embryonic shell.

In Cyclas the embryonic shell makes its appearance as a simple, nearly circular cup, which occupies the dorsal midline of the body, and soon becomes saddle-shaped, and prolonged to form two flaps, which run down into the sides of the body. This embryonic shell does not contain any calcareous matter, but appears to be wholly made up of a chitinous excretion from the cells of the shell area. After it has extended out onto the sides of the body, calcareous matter begins to be deposited on its inner surface, at two points, one on each side of the body. These centres of calcification grow on all sides, and become the calcareous valves of the shell, and the flaps of the primitive shell become the epidermic coverings of the outer surfaces of the two valves. The two centres of calcification grow towards, but not quite up to the medium

line of the dorsal surface, and these upper edges are united by the middle portion of the primitive shell, which becomes converted into the hinge ligament.

In Anodonta, and apparently in Unio, the process is somewhat similar, but each calcareous valve is formed by the union of a number of patches which are deposited on the inner surface of the embryonic shell at several centres of calcification.

In the oyster the primitive shell appears to be wanting, and the two valves of the shell correspond to the two centres of calcification which are present in Cyclas.

The fact that the primitive shell of Cyclas or of Anodonta closely resembles the embryonic shell of a Gasteropod, a Pteropod or a Cephalopod in appearance and shape, as well as in position and method of formation, would seem to indicate that the manner in which the shell of Cyclas is formed is the primitive method, and the process, in the oyster, a secondary modification.

THE MANTLE.

The manner in which the lobes and cavity of the mantle are formed in the oyster appears to differ slightly from the process as it is exhibited during the development of the fresh-water Lamellibranchs.

In Anodonta the mantle cavity is formed by an invagination of the body wall between the free ventral edges of the valves, and in Cyclas the mantle folds off from the sides of the body in advance of the growing shell. The process in the oyster is about half-way between that in Cyclas and that in Anodonta. The mantle is formed as a ridge or fold of the integument on each side of the body, but this ridge is situated at the ventral edge of the shell, not, as in Cyclas, in advance of it.

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THE DEVELOPMENT OF THE OYSTER.

BY W. K. BROOKS.

EXPLANATION OF THE PLATES.

Unless the contrary is stated the figures are drawn with a magnifying power of 250 diameters; Zeiss. F. 2, but it was necessary to amplify the sketches considerably in order to reproduce, by the process of photo-engraving, the features which this magnifying power rendered visible, and the figures as they are reproduced are of about twice the diameter of camera sketches made with the same magnifying power.

The first thirty-two figures show the process of segmentation. Figure 1 is an egg at the end of the first period of rest; Figures 2, 3, 4, 5, 6 and 7, the changes during the first period of activity; Figures 8, 9, 10, 11, 12 and 13, the changes during the second period of rest; Figures 14, 15 and 16, those which take place during the second period of activity; 17, 18 and 19, those which take place during the third period of rest; 20 and 21, during the third period of activity; 22, during the fourth period of activity; 23, during the fifth period of activity, and the remaining figures show more widely separated stages. In all the figures of segmentation, except 29, 30 and 31, the formative pole is above and the nutritive pole below.

PLATE I.

Figure 1.—Eggs two hours and seven minutes after fertilization. It is now perfectly spherical, with an external membrane, and the germinative vesicle is not visible.

Figure 2.—The same egg two minutes later. It is now elongated; one end is wider than the other, and a transparent area at the broad end marks the point where the polar globules are about to appear. At the opposite end the external membrane is wrinkled by waves which run from the nutritive towards the formative pole in rapid succession for about fifteen seconds.

Figure 3.—The same egg two minutes later.

Figure 4.—The same egg two minutes later. The yolk has become pear-shaped. The polar globule has appeared at the formative pole, in the middle of the broad end of the pear, and the nutritive end of the egg is now less granular than the formative end.

Figure 5.—The same egg two minutes later. Three equidistant furrows have made their appearance, separating it into a single mass at the nutritive pole, and two at the formative pole. At this stage the three masses are about equal in size.

Figure 6.—The same egg two minutes later. The first micromere, *c*, is now perfectly separated, and smaller than the second, *b*, and each is smaller than the macromere, *a*.

Figure 7.—The same egg one minute later. Both micromeres are separated and are spherical, as is also the macromere. This stage ends the first period of activity.

Figure 8.—The same egg forty-five seconds later. The two micromeres have begun to fuse with each other, and the second micromere, *b*, is also partially fused with the macromere, *a*.

Figure 9.—The same egg one minute later. The first micromere, *c*, has also begun to unite with the macromere.

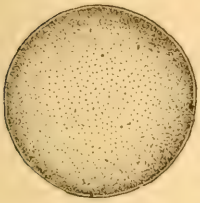


Fig 1

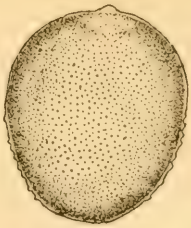


Fig 2.

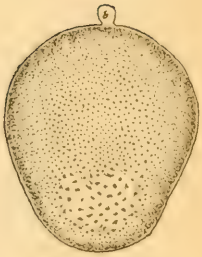


Fig 3.

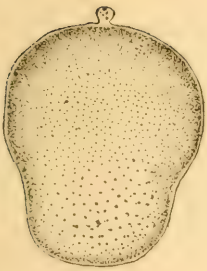


Fig 4.

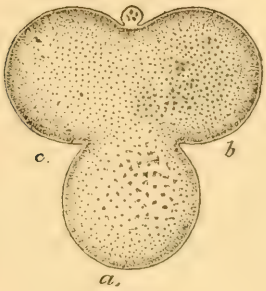
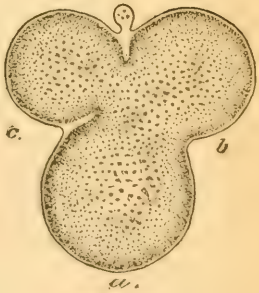


Fig 5.



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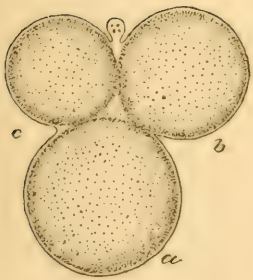

Fig 7.

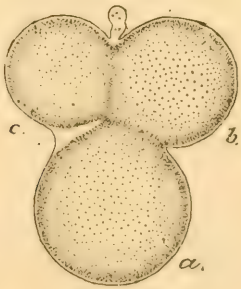

Fig 8.

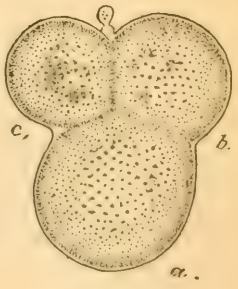

Fig 9

W. K. Brooks, Del.

Figure 10.—The same egg one minute later. The line between the second micromere and macromere has disappeared, and the first micromere, *c*, now projects from one end of the elongated mass formed by the union of the spherules *a* and *b*.

Figure 11.—The same egg three minutes later. The fusion of *a* and *b* is now complete, and a large transparent vesicle is now visible in the first micromere, *c*, and another in the compound mass, *ab*.

Figure 12.—The same egg two minutes and thirty seconds later.

Figure 13.—Another egg, about two minutes later. This is the true resting stage, at the end of the second period of rest. The two vesicles have become irregular. The remains of an external membrane adhere to one side of the egg.

Figure 14.—The same egg seven minutes later than Figure 13. The compound mass, *a* and *b*, is elongated, the first micromere, *c*, is well defined, and waves travel from the nutritive towards the formative ends of the two masses. Two segmentation nuclei occupy the positions of the large vesicles of earlier stages. This stage is the beginning of the second period of activity.

Figure 15.—The same egg one minute later. The second micromere, *b*, is now well defined, as well as the first.

Figure 16.—The same egg one minute later. This stage marks the end of the second period of activity. The formative end of the egg is now occupied by four micromeres, two of which seem to be the products of the division of the first micromere, *c*, and two of them the products of the second, *b*.

Figure 17.—The same egg two minutes later, at the commencement of the third period of rest. The second micromere, *b*, has again begun to fuse with the macromere, *a*.

Figure 18. The same egg three minutes and thirty seconds later. The second micromere is no longer separated from the macromere, and mass, *a* and *b*, formed by their union is nearly spherical.

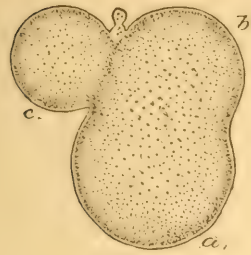

Fig 10.

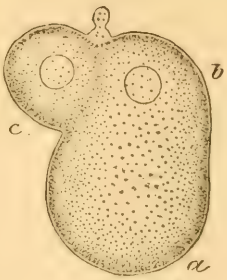

Fig 11

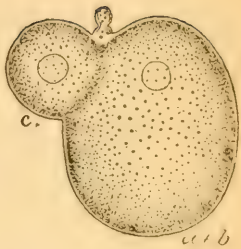

Fig 12

Fig 13

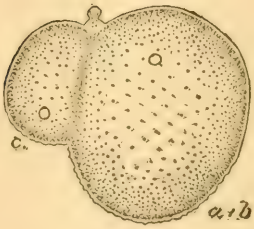

Fig 14.

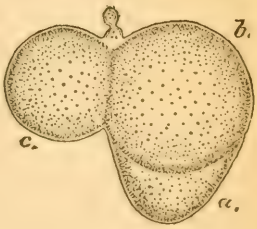

Fig 15

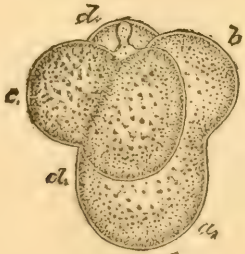

Fig 16.

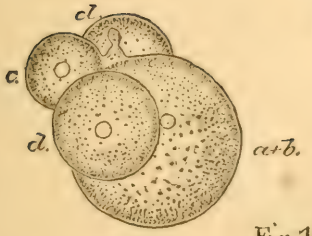

Fig 18.

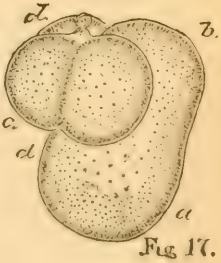

Fig 17.

W. K. Brooks, Del.

Figure 19.—The same egg two minutes and a half later, at the end of the third period of rest, viewed at right angles to Figure 18.

Figure 20.—The same egg thirteen minutes later, and in the same position as Figure 18. The spherule, *c*, of Figure 19, has divided into two, and the second micromere, *b*, has become prominent, so that there are five micromeres at the formative pole.

Figure 21.—The same egg one minute later, and in the same position as Figure 19.

Figure 22.—The same egg in the position of Figure 20, fifteen minutes later than Figure 21, and in the fourth period of activity. There are now seven micromeres at the formative pole, six on one side of the polar globules and one, the second micromere, *b*, on the other.

Figure 23.—The same egg twenty-one minutes later, viewed from the side opposite the second micromere. The cells which have been formed by the division of the micromeres of the stage 19, now form a layer, the ectoderm, which rests, like a cap, on the macromere, *a*.

Figure 24.—The same egg five hours and fifteen minutes later, in the same position as Figure 22, but not quite as much magnified. On one side the polar globule is still separated from the macromere, *a*, by a single spherule—the second micromere, *b*. Opposite this the growing edge, *g*, of the ectoderm is spreading still farther down over the macromere. At the point *g*, and at four other points, are pairs of small cells, which have evidently been formed by the division of the larger spherules.

Figure 25.– Another egg at about the same stage.

Figure 26.—The egg shown in Figure 24, fifty-five minutes later. The macromere, *a*, is almost covered by the ectoderm, and the second micromere, *b*, has divided into a number of spherules. At the growing edge, *g*, an ectoderm spherule is seen separating from the macromere.

Figure 27.—A similar view of an egg twenty-seven hours after impregnation. The macromere is almost covered by the ectoderm, *ec*, and is not visible in a side surface-view. At *g* is an ectoderm spherule, which is separating from the macromere.

Figure 28.—Optical section of the same egg; *ec*, ectoderm; *en*, macromere, divided into two spherules. No segmentation cavity can be seen in a normal egg at this or any of the preceding stages.

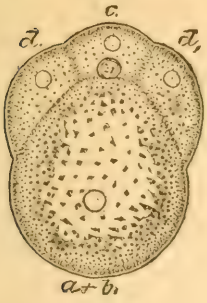

Fig 19

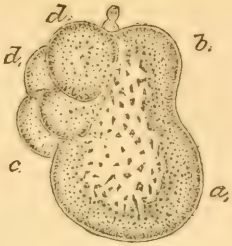

Fig 20.

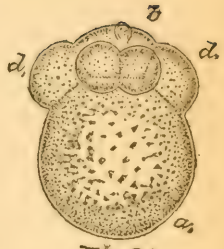

Fig 21.

Fig 22.

Fig 23

Fig 24.

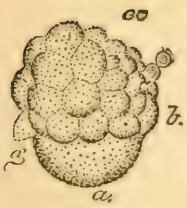

Fig 25.

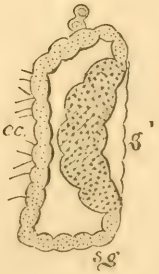

Fig 31.

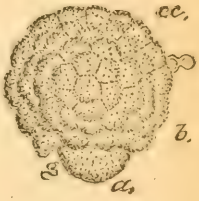

Fig 26.

Fig 27

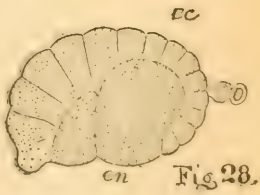

Fig 28.

W. K. Brooks, Del.

Figure 29.—View of the nutritive pole of an egg a few hours older.

Figure 30.—View of the formative pole of a still older egg.

Figure 31.—Optical vertical section of a somewhat older egg, figured with the polar globule above and the ectoderm to the right. The egg is now flattened from above downwards, and is disc-shaped in a surface view. The macromere has given rise to a layer of larger granular cells, which are pushed in so as to form a large cup-shaped depression. The more transparent ectoderm, *ec*, now carries a few short cilia scattered irregularly, and the two layers are separated from each other by a segmentation cavity. This figure is in Plate III.

Figure 32.—Surface view, and

Figure 33.—Optical section of the embryo at the first swimming stage. The ectoderm has folded upon the endoderm, so as to form a primitive digestive cavity, with an external opening, *g*. The cilia of the velum have now made their appearance around the area occupied by the polar globule. This was not present in the egg from which the figure was drawn, but it was seen in other eggs, and is shown in a later stage of another embryo, Figure 76.

Figure 34 and Figure 35.—Two surface views of the embryo shown in Figure 32.

Figure 36.—An older embryo, in the same position as Figures 32 and 33. The external opening of the primitive digestive tract has closed up, and the two valves of the shell have appeared in the place which it had occupied. The endoderm has no connection with the exterior, and no central cavity could be seen.

Figure 37.—A somewhat older embryo, figured with its dorsal surface above. There is a large, central, ciliated digestive cavity which opens externally by the mouth, *m*, which is almost directly opposite the primitive opening, the position of which is shown by the shell, *s*.

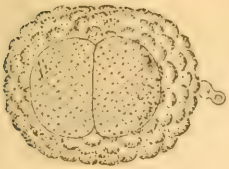

Fig 29.

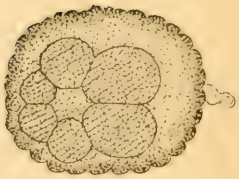

Fig 30

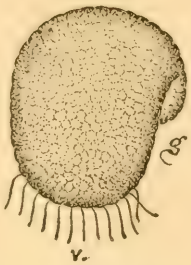

Fig 34.

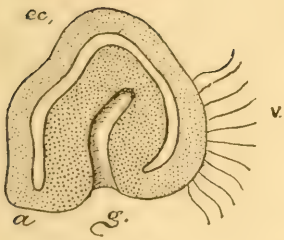

Fig 33.

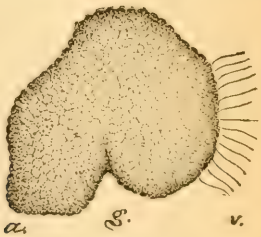

Fig 32.

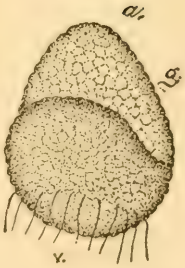

Fig 35.

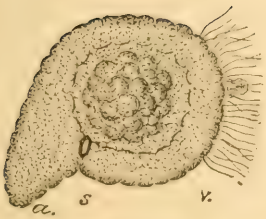

Fig 36.

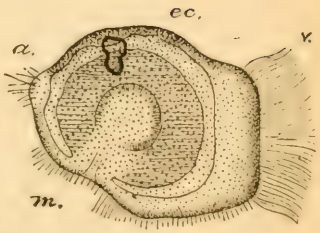

Fig 37.

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Figure 38.—A similar view of a still older embryo. The shell, *s*, has increased in size, and the digestive tract has two openings, the mouth, *m*, and the anus, *an*, which are very near each other on the ventral surface.

Figure 39.—The opposite side of a still older embryo, in which the body-wall begins to fold under the shell, to form the mantle, *m*.

Figure 40.—Dorsal view of an embryo at about the same stage.

Figure 41.—Dorsal view of an embryo at the stage shown in Figure 38, with its valves extended; *rs*, right valve of shell; *ls*, left valve of shell; *an*, anus; *a*, anal papilla; *ma*, mantle; *v*, velum; *b*, body-cavity; *st*, stomach.

Figure 42.—View of left side of a still older embryo; *i*, intestine. Other letters as in Figure 41.

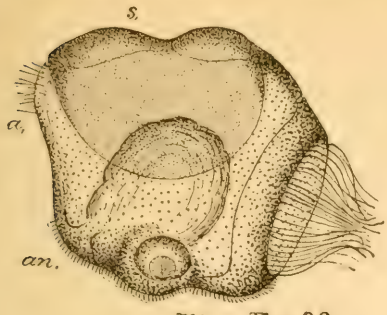

Fig 38

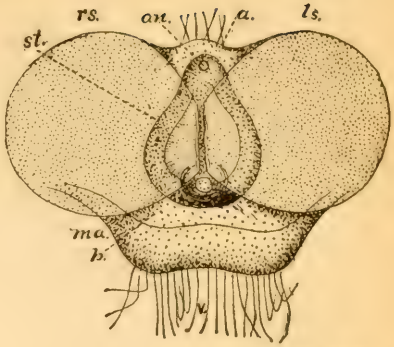

Fig. 41

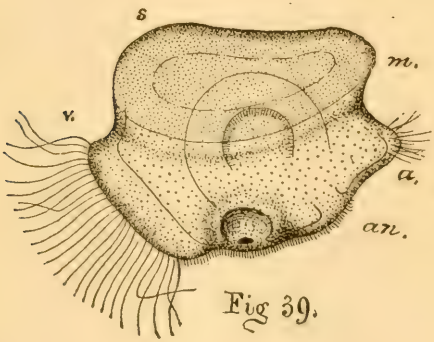

Fig 39.

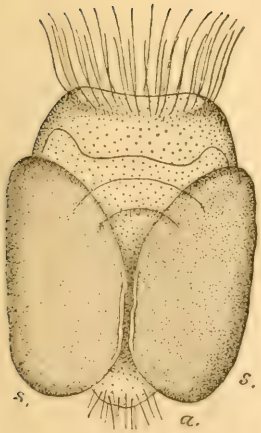

Fig 40.

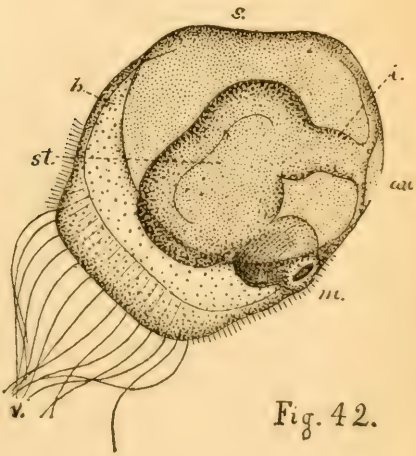

Fig. 42.

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PLATE VI.

Figure 43.—Dorsal view of an embryo six days old, swimming by the cilia of its velum.

Figure 44.—View of right side of another embryo at the same stage; *mu*, muscles; *l*, liver. Other letters as in Figure 41.

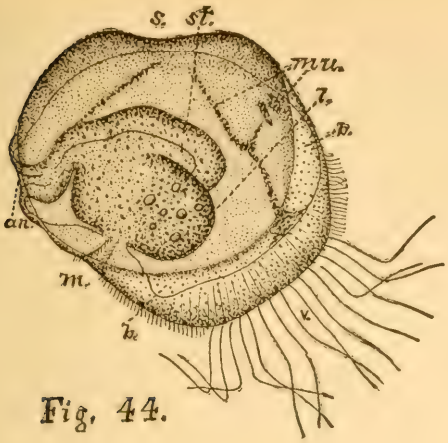

Fig. 44.

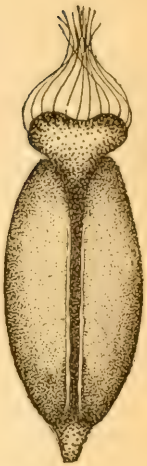

Fig 43.

Fig. 47.

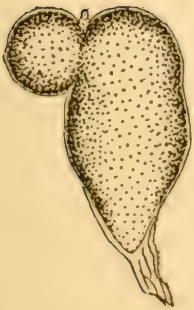

Fig. 46.

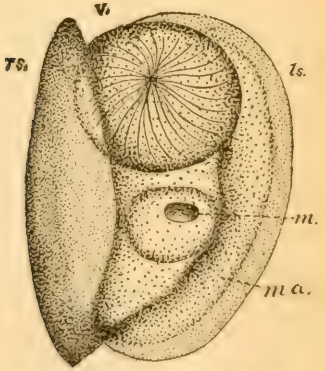

Fig. 45.

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PLATE VII.

Figure 48.—The seminal fluid of a ripe male oyster, mixed with water, and seen with a power of 80 diameters. Zeiss. a. 2.

Figure 49.—Fluid from the ovary of a ripe female oyster, seen with the same magnifying power.

Figure 50.—Seminal fluid of a ripe male oyster, magnified 500 diameters.

Fig. 48.

Fig. 50.

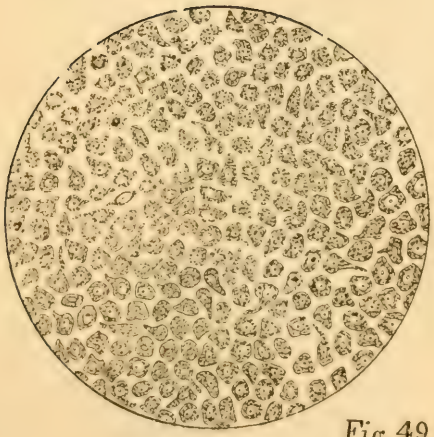

Fig. 49.

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PLATE VIII.

Figure 51.—Egg a few minutes after mixture with the male fluid magnified 500 diameters.

Figure 52.—Egg about thirty minutes after fertilization magnified 500 diameters.

Figure 67.—Section of a portion of the visceral mass of a male oyster magnified 250 diameters. The surface epithelium of the body is shown at the lower end of the figure. Above this is a loose, thick layer of wrinkled cells, which have the appearance of adipose cells from which all the fat has been removed. Above this layer is a large duct, lined with epithelial cells, and filled with ripe spermatozoa, which have been poured into it from two follicles which communicate with it on each side. Above this are sections of a number of the follicles of the testis, in three of which the contents are figured

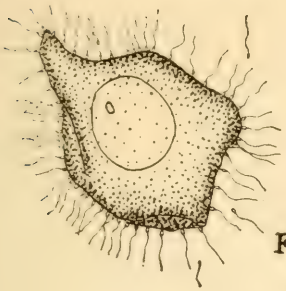

Fig 51.

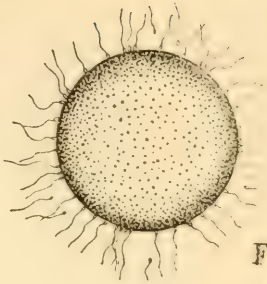

Fig. 52.

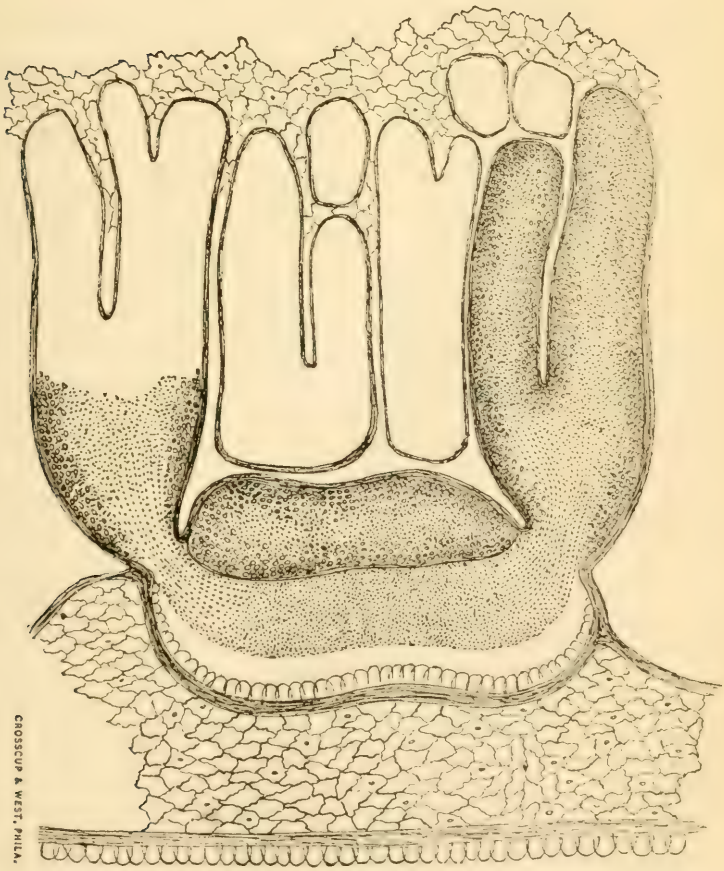

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Fig. 67.

PLATE IX.

Figure 53.—Section of a portion of the viscera mass of a female oyster magnified 250 diameters; *a*, epithelium of the surface of the body; *b*, layer of connective tissue; *c*, layer of wrinkled cells, which are probably fat cells, from which all the fat has been removed; *f*, sections of ten ovarian follicles; *e*, the ovarian eggs.

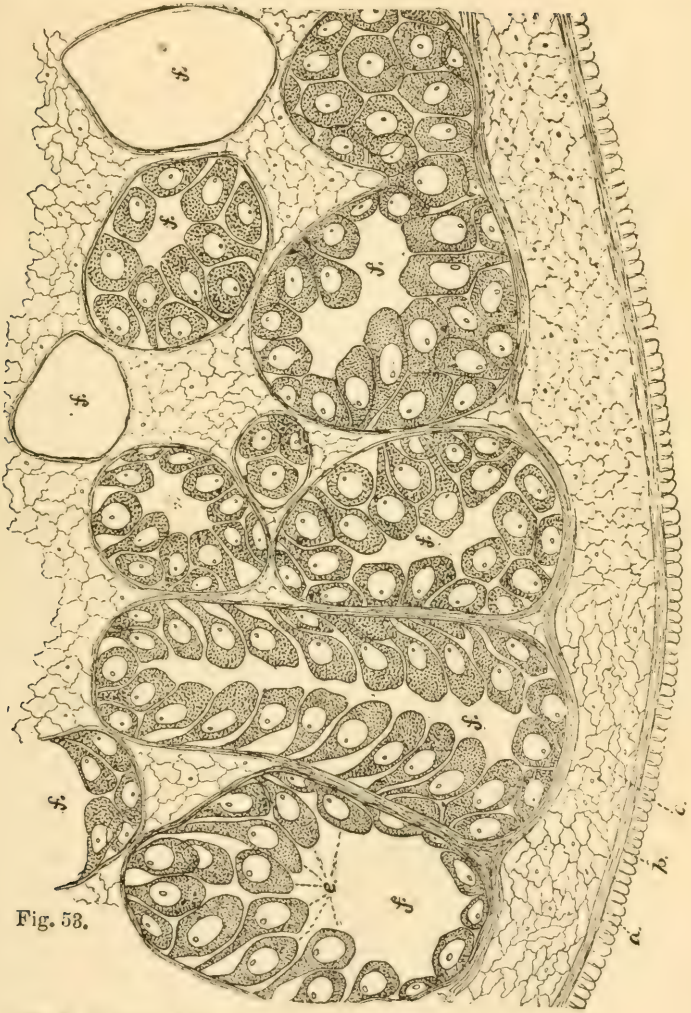

Fig. 53.

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PLATE X.

Figures 54–66.—Abnormal or direct form of segmentation.

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W. K. Brooks, Del.

EXTRACTS FROM REPORT

OF

Francis Winslow,

Master U. S. Navy, Assistant Coast and Geodetic Survey,
Commanding Schooner Palinurus,

MADE TO

CARLILE P. PATTERSON,

Superintendent Coast and Geodetic Survey,

OF

INVESTIGATIONS OF THE OYSTER BEDS IN TANGIER AND POCOMOKE SOUNDS AND PARTS OF THE CHESAPEAKE BAY, CONDUCTED DURING PORTIONS OF THE YEARS 1878 AND 1879.

PART I, 1878.

These extracts, containing information valuable to the people of Maryland, are published by permission and through the courtesy of the Superintendent in charge of the Coast and Geodetic Surveys.

PART I.

Report of Investigations Made from August 21st to October 14th, 1878.

TANGIER AND POCOMOKE SOUNDS.

The charts showing the oyster beds and limits of oysters in these Sounds have been constructed from the *data* collected during the progress of the work.

Only the natural beds are shown on them, and no attempt was made to carry the investigation beyond the Sounds, except in the cases of the Manokin and Big Annemessex Rivers, where the beds were large enough to make their delineation and study advisable.

The beds have been named from the solid "rocks" which they surround, and are indicated on the charts by the darkest shades. In many cases it was a matter of some difficulty to determine the outlines of the beds proper, on account of their peculiar formation.

It would have given an erroneous impression to have considered either the solid unbroken portions as the beds, or to have taken the entire area upon which oysters are found, and I have therefore adopted a proportion of 0.1 oysters to the square yard as the standard by which to determine the outlines, all positions where the proportion fell below that standard being excluded from the beds, unless other circumstances have led me to a different decision.

The light shades on the charts show the area covered by scattered oysters, and as already explained, must be considered only approximate. The broken lines show areas where the oysters are very widely separated. The dark blue lines

have been drawn through those positions where the proportion of oysters to the square yard was above the average.

In designating the oysters, the term "young growth" has been applied to the small oysters that were evidently but one year or one and a half years old. The term "young" has been applied to small oysters of the last brood that were found clinging to the mature and old shells and were, on an average, about one-half or three quarters of an inch in length, or under.

Tangier Sound extends north and south, in round numbers, thirty-six miles, from Watts' Island to the head of Fishing Bay and each side of the channel for thirty-two miles is lined with oyster beds of greater or less extent. These beds are continued, though the oysters are generally scattered, through Kedge's, Hooper's and Holland Straits and on the shoal between Smith's and Tangier Islands. On each side of the channels into the Nanticoke, Manokin and Big Annemessex Rivers, beds are found and to a less extent in the Wicomico and Little Annemessex Rivers.

By reference to the chart, it will be seen that the only parts of the Sound unoccupied by oysters are a short space, one mile in length, off Deil's Island; a space of two miles north of Jane's Island Light and between the Big and Little Annemessex Rivers and a stretch of two and a half miles on the western side of the Sound off Reach Hammock and the northern part of Tangier Island.

With these exceptions, the oysters are to all intents, continuous and the total area covered by them amounts to 69,127 square nautical miles.

The area of the beds proper or that part of the total area on which the proportion of oysters to the square yard was at least 0.1, is 17,976 square nautical miles.

Whenever the names of the beds could be ascertained they have been given to them but in some cases they could not be and I have included them under general heads.

Taking them from the head of Fishing Bay in regular order, they are twenty-eight in number.

* * * * * * *

DENSITIES.

Specimens of the bottom water taken on each bed, at all stages of the tide, have been tested with the hydrometer and its readings reduced to a standard temperature of 60 degrees Fah. These results show a maximum density of the waters of Tangier Sound of 1.0164, which was found in the lower part, about the California Rock, at half flood tide. The minimum density of 1.0111 was found in the upper part of Fishing Bay, with the tide three quarter ebb. The following table shows the maximum and minimum density on each bed, with state of tide and remarks:

COMPARISON OF DENSITIES—TANGIER.

The figures represent the excess of Density over that of Distilled Water, which is represented as 1.000.

Bed.	Max. Density.	Tide.	Remarks.	Diff.	Min. Density.	Tide.	Remarks.
Fishing Bay	1.0136	H. W.	Southern part.	.0025	1.0111	¼ & ¾E.	Extreme Northern part.
Were Point	1.0139	½Fl.	In Chan. to Hooper's Sts.	.0022	1 0117	L. W.	
Shark's Fin	1.0143	H. W.	Edge of Main Channel.	.0025	1.0118	¾E.	Middle of Bed.
Nanticoke M. G	1.0136	H. W.	West of Channel.	.0017	1.0119	½E.	Middle of Bed.
Clump Pt	1.0118	¾Fl.	Only one specimen.	.....	.....	.....	No specimen.
Horsey's Bar, Tyler's Rock, Drumming Shoal	1.0132	¼E.	Only one specimen.	.0012	1.0120	½Fl.	Only one specimen.
Grass Tangier	1.0144	¼Fl.	In the Channel.	.0024	1.0120	L. W.	Middle of Bed.
*Turtle Egg Rock	1.0120	¼Fl.					
Chain Shoal	1.0145	¼Fl.		.0022	1.0123	¾Fl.	
Mud Rock	1.0144	¾Fl.		.0008	1.0136	¾E.	
Muscle Hole	1.0157	¼E.		.0012	1.0145	L. W.	
Piney Island Bar	1.0150	¼E.	South of Beds.	.0019	1.0131	¼E.	Middle of Bed.
Manokin River	1.0152	¼E.	Lower Beds	.0014	1.0128	½E.	Upper Beds.
Big Annemessex	1.0151	H. W.	Western Beds.	.0007	1.0144	½E.	Eastern Beds.
Harris Rock	1.0153	¼E.	Southern Beds.	.0007	1.0146	H. W.	
Terrapin Sands	1.0159	¾E.	Strong Southerly Winds.	.0015	1.0144	¼Fl.	Light Southerly Breezes.
Rock off Jane's Island	1.0156	½E.		.0013	1.0143	¾Fl.	
Great Rock	1.0159	¼Fl.		.0011	1.0148	H. W.	
Woman's Marsh	1.0160	¾E.	Opposite opening between Tangier & Smith's Isl.	.0016	1.0144	¾Fl.	
Little Thoroughfare	1.0158	¾E.		0009	1.0151	½Fl.	
Great Thoroughfare	1.0157	¼F. ¾E.		.0005	1.0152	¼Fl.	
California	1.0164	½Fl.		.0012	1.0152	¾Fl.	
Johnson's Rock	1.0161	¼Fl.		.0013	1.0148	¼E.	
Oak Hammock	1.0160	¼E.		.0002	1.0158	½E.	

* All specimens taken on Flood. This is Minimum Density.

By consulting the table, it will be seen that the state of the tide has but little influence upon the density, though the depth of the water has and the prevalence of strong winds may increase or diminish it. There is shown a gradual and constant increase of density as the southern portion of the Sound, where it opens upon the Chesapeake, is approached.

There is also an increase of density when in the vicinity of the openings into the Bay and a decrease in the various rivers and off their mouths.

Though the density of the water increases, yet the difference between the maximum and minimum densities steadily decreases to the southward, showing that the oysters on the northern beds are exposed to greater fluctuations of density, and probably salinity, than those on the beds to the southward.

There were no heavy rains during my stay in the Sounds and the densities given therefore show only the condition of the water in that respect during dry weather. I was informed that there was a noticeable change in its character about the mouths of the tributaries of the Sounds, after a heavy rainfall and the effect upon the oysters was also perceivable.

The difference between the maximum and minimum densities of the Sound amounts to 0.0053; but the difference between the maximum and minimum densities on each bed will give a more correct idea of the changes to which the oysters are exposed. The greatest difference is 0.0025, which takes place over the Shark's-Fin and Fishing Bay beds and the least difference over any of the main beds is that on the Little Thoroughfare, which amounts to 0.0009.

It would be perhaps still more correct to divide the Sound into several parts and consider the fluctuation of densities over them thereby assembling a larger number of observations.

Throwing out the Fishing Bay beds, which by their position are removed to a great extent from the conditions affecting the other beds and including all those south of Clay Island as far as Piney Island Bar, when the influence of the Manokin and Annemessex Rivers would be felt, the difference of density amounts to 0.0028.

The difference of density over the beds south of Little Island and north of Little Annemessex River is 0.0031.

The difference of the beds south of Jane's Island Light is 0.0020.

These differences show that the greatest fluctuation is over the beds in the middle of the Sound and is probably due to the influence of the Big Annemessex and Manokin Rivers and the waters entering by Kedge's Straits.

Throughout the Sound there is a marked difference between the densities of the water taken about the latter part of August and the first part of September and those taken in October.

This difference is given in the following table:

Bed.	Date First Observat'n.	Date Second Observat'n.	Difference in Density.	Bed.	Date First Observat'n.	Date Second Observat'n.	Difference in Density.
Fishing Bay.....	Aug. 24	Oct. 5	.0018	Manokin Bed.....	Aug. 27	Sept. 30	.0017
Were Point.....	24	5	.0014	Harris' Rock	29	Oct. 1	.0005
Nanticoke Middle Gr'd.	26	5	.0014	Great Rock..... ...	30	Sept. 28	.0007
Bed N. of Turtle Egg Is.	26	4	.0016	Woman's Marsh.	30	23	.0008
Chain Shoal.....	27	8	.0011	Great Thoroughfare....	Sept. 5	28	.0007
Piney Island Bar.	28	4	.0010	California..	6	26	.0009
				Johnson's Rock.....	6	20	.0010

It will be seen by the table that the observations were made at from two weeks to six weeks apart; that generally speaking, the amount of difference in the densities increases with the interval between the observations and that the northern beds and those in the rivers are exposed to greater fluctuations of density than the neighboring ones in the Sound.

If the change of density over the beds as shown by these tables, represents with approximate accuracy the change of salinity of the water, the fluctuation is too slight to seriously affect the beds or oysters but if the slightness of the change is due to organic matter held in solution by the waters of the ebb-tide, which would replace the salt of the flood, there may

be a much greater difference in the salinity of the flood and ebb than has been indicated by the hydrometer.

CURRENTS.

The general set of the currents in the Sound is north and south, following the main channel and diverging slightly about the mouths of the tributaries and straits.

The arrows on the chart show the direction and the letters and figures the state of the tide and velocity per hour, in miles and tenths, at such stations as are preserved in the record.

The influence of the wind has not been eliminated, and accounts for many irregularities, both of velocity and direction.

About slack water, especially of the windward tides, this influence was most apparent.

In Fishing Bay the currents follow the general bend of the shores and channel, setting over the lower portion, on the flood, to the northward; over the middle portion to the northward and westward, as far as Fishing Point and above that point and over the upper part of the bay, setting to the northward and eastward.

The maximum observed velocity of the flood current was 0.38 of a mile per hour.

The ebb in each portion of the bay sets in an opposite direction to the flood.

The currents about the northern part of the Were Point bed were measured during and after strong northeast winds, which accounts for the set to the southward and westward, and also for the slight velocity of the ebb, which was only 0.15 of a mile per hour, the northeast wind having lasted for two days and having driven a good deal of the water out of Fishing Bay.

Over the Shark's Fin the flood current sets to the northward and the ebb to the southward and eastward, most of the latter apparently coming from Hooper's Straits.

Its maximum velocity was 0.4 of a mile per hour. The observations of the strength of the flood current made on this bed, were too much influenced by the wind to be considered

reliable but the velocity immediately south of the bed was 0.5 of a mile per hour.

The currents of the Nanticoke channel and over the adjacent beds, set to the northward and eastward on the flood, following the bend of the channel, with a maximum velocity of 0.6 of a mile per hour.

The ebb over the major portion of the Middle Ground sets to the southward, with a velocity of 0.3 to 0.4 of a mile per hour on the first quarter, until it meets the current of the Wicomico, when it turns to the westward.

A strong current sets in and out of Rock Creek; over the Drumming Shoal and Cedar Rocks, the current sets N. N.E. on the flood, with a velocity of 0.4 of a mile per hour and S. S.W. on the ebb tide, with a velocity of 0.6 of a mile per hour.

Over the beds south of the Shark's Fin and Cedar Rock, and north of Piney Island Bar and Kedges Straits, the general set of the flood is to the northward, with an inclination towards Holland's Straits, when about Turtle Egg Island, and tending to the northward and westward off the Little Thoroughfare. The general set of the ebb while in the channel is to the southward, but on the Turtle Egg Island, Mud and Muscle Hole Rocks the set is to the southward and eastward.

The strength of these and all currents in the Sound is much influenced by the winds that have prevailed during the immediately preceding days and which it was impossible to eliminate in the space of time covered by this investigation.

Over the western beds, above Kedges Straits, the maximum observed velocity of the flood was 0.8 of a mile per hour, and a mean of all the velocities of the flood current was 0.4 of a mile per hour.

The maximum observed velocity of the ebb current was 1.0 mile per hour, and the mean of all velocities of the ebb was 0.3 of a mile per hour.

Over the Chain Shoal the maximum velocity of the flood was 0.7, and the mean velocity was 0.3 of a mile per hour.

The maximum velocity of the ebb was 1.0 mile and the mean velocity 0.5 of a mile per hour.

The flood current over Piney Island Bar sets N. N.W., or about in general line with the sound at that point. Its velocity on the third quarter, during and after northerly breezes, was 0.1 of a mile an hour, and probably it is seldom less than that.

The ebb current over the northern part of the bed sets S. S.E., but tends to the southward over the southern part.

The maximum velocity of the ebb during and after northerly breezes was 1.00 mile per hour, and the mean of all observations, taken under similar circumstances, gives a velocity of 0.4 of a mile per hour.

In the Manokin River the current follows the general trend of the channel, the flood setting to the northward until above Hazzard's Point, and then to the northward and eastward.

The ebb sets southwest, and, when it strikes the shoal off Piney Island, curves somewhat to the southward.

The currents shown on the chart were measured during light or gentle northeasterly breezes.

The maximum velocity of the flood was 0.4 of a mile per hour, and the mean of all the velocities of the flood 0.2 of a mile per hour.

The maximum velocity of the ebb was 0.5 of a mile per hour, and the mean velocity 0.2 of a mile per hour.

In the Big Annemessex River the current sets to the eastward on the flood tide, and to the westward on the ebb, curving to the southward on the latter as it approaches the mouth of the river.

The maximum velocity of the flood current was 0.4, and the mean velocity 0.25 of a mile per hour.

Of the ebb the maximum velocity was 0.5 and the mean velocity 0.33 of a mile per hour. The flood current sets over Harris Rock to the northward, with a maximum velocity of 0.33, and a mean velocity of 0.2 of a mile per hour. The ebb being somewhat influenced by the current out of the Annemessex and the sweep of the main current of the Sound sets to the southward and westward, with a mean velocity of 0.2 of a mile per hour. The maximum velocity observed was but a slight increase of the mean.

Over the Terrapin Sands the flood sets northwest, with a maximum velocity of 0.9 and a mean velocity of 0.7 of a mile per hour. The ebb sets southeast until near the buoy marking the shoal, where it turns to the southward. Its maximum velocity was 1.0 mile, and its mean velocity 0.9 of a mile per hour. The currents over the Terrapin Sands were measured during spring tides, and after light breezes and calms had prevailed for several days. Over the Woman's Marsh Rocks the flood sets about N. N.W., until in the vicinity of Horse Hammock, where it turns to the northward and eastward. The ebb sets S. S.W. over the upper part of the bed, and to the southward and eastward over the lower. There is a strong set in and out of the opening between Tangier and Smith's Islands.

The maximum velocity of the flood was 0.7, and the mean velocity 0.6 of a mile per hour. The velocity of the ebb was, maximum 0.8, and mean 0.4 of a mile per hour. These currents were also measured during spring tides.

Along the eastern side of the Sound, below Jane's Island Light, and over the several beds located on the eastern edge of the channel, the general set of the current is to the northward on the flood and to the southward on the ebb. The flood sets a little to the eastward or westward of north as the channel changes in direction, and about the northern part of the Great Rock sets strongly to the northward and eastward into the Little Annemessex. The ebb current out of that river forms a strong tide rip where it joins the main current due east of Jane's Island Light and on the northern part of the bed off that light.

The general set of the ebb is the reverse of that of the flood, and both currents follow the trend of the channel.

Through the Thoroughfare, opposite the California Rock, the flood sets east into Pocomoke on the first three quarters, and west on the last quarter.

On the ebb the set is westward on the first three and eastward on the last quarter, and this irregularity is communicated, to some extent, to the waters over the California Rock.

The maximum velocity of the flood current on the eastern

side of the Sound, below the Little Annemessex, was 0.3, and the mean velocity was 0.2 of a mile per hour. The maximum of the ebb was 0.8, and the mean 0.7 of a mile per hour. Most of these currents were measured during northerly winds, which would increase the ebb and diminish the flood currents, and probably they are more equal than the observations show them to be.

Over the Oak Hammock Rocks the flood sets to the northward and westward, and the ebb to the southward and eastward, with a velocity of from 0.1 to 0.2 of a mile per hour.

Reviewing the currents, it will be seen that the strongest on both tides were those over Terrapin Sands during the spring tides, their velocity being about one mile per hour.

As the observations over the Sound were made during many various states of the weather and of tide, the highest velocity obtained is probably as great as ever sets over any of the beds.

The velocity within wide limits, however, is not so important to the oysters as the direction of the current, and that has been ascertained with, I hope, sufficient exactness to assist, so far as it can, in the study of the beds.

DEPOSIT.

It would require a much longer period of observation than was at my disposal, and a much more extensive and careful investigation of the character of the water and bottom of the Sound than I was enabled to make to allow me to speak with authority or exactness upon this subject; but from the information collected from the most intelligent of the oystermen, whose experience on the beds was considerable, I am of the opinion that there is little or no systematic deposit going on upon any of the beds of the main Sound.

There must be some sediment contained in the waters of the rivers and creeks, but it appears to be deposited on those beds near their mouths. In the upper part of Fishing Bay, on the Clump Point Rocks, Middle Ground of the Nanticoke, in the Manokin and Big Annemessex Rivers there is a larger amount of mud in the surface, and underneath, than else-

where in the Sound. Those beds lying in deep water are particularly free from an undue proportion of mud on the bottom, the shoalest beds having the thickest mud covering.

If there was a constant and increasing deposit upon the beds they would long ago have disappeared, or at least have become of much smaller area, but the reverse is the case, the beds increasing in area constantly.

They are, however, exposed to one species of deposit which is very injurious. Heavy gales occurring in winter and summer frequently tear up the large quantities of grass, seaweed and sponge on the sand shoals about the Sound and deposit it upon the beds. If this occurs in summer, when there are a smaller number of dredgers at work, the effect is very injurious, the "cultch" being covered, and the young, if spawned, smoothered by the grass, weeds, sand and mud which it collects. The California Rock, Piney Island Bar and Manokin beds are those most subject to this evil.

The gales also have the effect of covering the scattered oysters on the leeward sands, which process is called "sanding," and, from what I could learn, appears to be a very injurious one. The oysters are buried, and the bottom becomes smooth and hard. Where at least thirty bushels of oysters could be taken previous to a gale, not one oyster could be found subsequent to it.

The winter gales have the greatest effect, owing probably to their greater severity and direction, which is from the northward and westward. The "sand" oysters are found in largest numbers on the eastern shores of the Sound, and about Kedge's and Hooper's Straits, consequently they would feel a northwesterly gale much more than one from the opposite direction.

They are said not to recover from the "sanding" for several months, and upon their reappearance, are noticeable on account of the whiteness of their shells.

Though there were several very heavy blows while we were in the Sound, they were not of sufficient severity to produce the effect spoken of, and if they had been I should not have been able to detect it, on account of the shallowness of the

water in which the scattered oysters lie, which prevented the schooner's dredging for them.

EFFECT OF GALES AND ICE.

As there was no opportunity for me to investigate this question in person, the examination of the beds having been accomplished during the summer and autumn months, the following information is derived from the queries put to the oystermen and persons inhabiting the shores of the Sound.

The heaviest gales during the Winter season are from the northward and westward. During the summer season, from the southward, and southward and eastward. The gales from the eastward, southward and eastward, and southward, cause an increase of depth over all the beds, amounting sometimes to two feet, and the northerly and westerly gales a contrary effect, but not sufficient to leave any of the natural beds uncovered, except one or two small patches in Fishing Bay.

Gales from any direction cut away the leeward shores and points considerably, especially when they are of a sandy nature.

Those parts of the Sound suffering most in this respect are Bishop's Head, Haines' Point and Diel's Island, Little Island, the shores about and near Jane's Island, Great Fox Island, the shores about Horse Hammock, and the southern part of Watts and Tangier Islands.

Cod Harbor, in Tangier Island, is said to be filling up with the washings of the sand-spit to the southward.

Though it is said the amount washed away from these points is considerable, no additional deposit was ever noticed on the beds, nor did the gales appear to affect them in any way other than has already been described, except in conjunction with the ice in the winter. Ice never rests upon the main beds except in a few isolated cases where there happens to be a very shoal spot on the bed.

Occasionally the ice will ground on some of the small rocks in Fishing Bay and once in a while on the Woman's Marsh Rocks but not often.

The injury done the oysters by the grounding depends upon the length of time the oysters are in contact with the ice.

If it only touches in a few places not much harm is done; indeed, it is supposed to protect the majority on the bed by covering them, but where there is a contact all over the "rock," the oysters are killed in a short space of time.

The number of points in the Sound where it is possible for the ice to rest is very inconsiderable, and not many of the animals are destroyed by the grounding of the ice, though they are affected seriously by its long continued presence.

The winter gales break up the ice fields and pile them up in immense masses on the leeward shores and over the adjacent beds. The Shark's Fin bed suffers particularly in this respect. A good deal of damage is done to the shores by the ice and the oysters feel the effect, showing it by becoming what is called "Winter-killed," or poor and weak, having a slimy, sickly appearance when opened.

Many die on the beds from this cause and after the disappearance of the ice, ten days or two weeks must elapse before they are fit for marketable purposes.

Ordinary cold weather and a moderate amount of ice is said to improve the fishing, the oysters appearing to be drawn more to the surface of the bed, and the shells to sink more toward the bottom. My informants said this effect was quite noticeable.

No one that I was able to interrogate had ever seen an oyster frozen *in the water*, and the impression was that so long as the oysters were covered they would recover from any ill-effects of ice or ordinary cold weather.

POCOMOKE SOUND.

Pocomoke Sound extends from Watts' Island, in a north northeasterly direction, twelve and a half miles.

The main channel is narrow with a varying depth of water, the main body of the Sound being covered by shoals with from seven to eighteen feet of water over them.

Long sand-spits make off from most of the points and islands and separate the channels into the different creeks from each other.

The Sound is about nine and a half miles broad from shore

to shore about its middle, but the channel occupies only one and a quarter miles of this space.

The change of depth is gradual, except between Watts' and Beach Islands, near the southern extremity of the Sound, where the change from deep to shoal water is sudden. About the upper and northeastern portion the depth is more uniform, the deep channel shoaling to about twelve feet, and that water being but slightly diminished close to the shores.

The beds do not as in Tangier Sound, cover the shoals on each side of the channel, the majority being found on the eastern side. Only two beds are to the westward of that part of the channel, where the water is deeper than three or four fathoms.

The total area covered by oysters to a greater or less extent in this Sound, is 34.118 square nautical miles. This area is that enclosed on the chart by the boundaries of scattered oysters, and is but approximate, as previously explained.

The solid beds, comprising all parts of the Sound where oysters were found in a greater proportion than 0.1 to the square yard, or where the bed was found to be to all intents, solid "oyster-rock," or comparatively unbroken, contains a total area of 4.519 square nautical miles.

The groups or rocks are not always contiguous, being separated by the channels into the different creeks and rivers and by mud-sloughs and spaces.

In only one case have the beds extended across the channel, and peculiar circumstances account for that exception.

Generally speaking the beds will be found to lie on each side of the main channel in the Sound and on each side of the channels into the rivers. Taking them in order from the mouth of the Pocomoke River to the entrance to the Sound, there are seventeen of a sufficient size to justify a separate consideration and name.

I have called them by the names given by the local oystermen to the solid "oyster-rock," which was probably the origin of the bed.

They are: The Old Rocks and New Plantation Rocks, Buoy Rock, Potter's Rock, Slatestone Flat Rock, Dog-Fish

Rock, Drum-Bay-Point Rock, Trevise's Rock, Shell Rock, Buoy Spit Rock, Muddy Marsh Rocks, Bird Rocks, Hern Island Rock, Beach Island Rock, Parker's Rock, and Brig Rock.

In considering and describing the beds I shall separate the first ten from the others and as they are subjected to very similar conditions of bottom, current, and density of water, shall treat them under one head, as the Pocomoke Rocks.

SCATTERED OYSTERS IN POCOMOKE SOUND.

The area covered by scattered oysters is only approximate, it being very difficult to accurately define the limits. Generally speaking the one fathom curve will nearly mark the inshore limit, while the soft muddy bottom of the main channel will define the outer one. The depth of water over the scattered oysters and the character of the bottom can be ascertained by reference to the chart. No oysters were found in the deep channels nor on the shoal sand spits.

The oysters are scattered singly and in groups, but usually grow singly, though numbers of small beds of a few hundred yards area are included within the limits of scattered oysters.

In the vicinity of the Messongo and Guilford Creeks, the oysters seem to be scattered in that manner, the spaces between the groups being proportional to their sizes. Very few oysters are found along the edge of the shoal on the western side of the channel south of the Muddy Marsh. In the channel itself no oysters were found. Opposite Beach Island, in from thirteen to fourteen fathoms, a few clams and shells were brought up. In this case, however, the bottom was of hard sand.

The area covered, to a greater or less extent by the scattered oysters comprises 122,117.500 square yards, or 29.599 square nautical miles.

The proportion of oysters over this area, as near as I could ascertain, was about one hundred and seventeen thousandths to the square yard.

DENSITIES

The density in the water over the different beds is given in the Record, Volume 1.

The least density found, that of 1.0113 was across the mouth of the Pocomoke River at low water of the spring tide.

The water of the greatest density, that of 1.0174 was taken from about the middle of the Sound, over the Bird, Buoy Spit, Muddy Marsh and Hern Island Rocks.

The density over the beds, therefore, would be within those limits, the variation amounting to 0.0061. The effect of the tide does not appear to be invariable, as the greater densities were found as frequently on the ebb tide as on the flood. The depth of water and the prevailing winds have probably a greater effect than anything else, as the density increases with the depth, and the prevalence of easterly or south easterly winds backing the waters of the Bay up into the Sound, would have a like effect.

As the variation noticeable during the space of eleven days, under various conditions of weather, were so small, it can hardly be much greater at any time, and unless much greater shown by the records if representing the change in salinity, can have but very little if any effect upon the oysters on the beds. By the following tables of comparison it will be seen that the fluctuation of density is, as in Tangier Sound, greatest at the head of the Sound and least at its entrance, with an increased fluctuation where the influence of the Messongo and Guilford Creeks are felt.

On the beds above the Bird Rock the difference of density noticed was 0.0061. On the remainder of the beds the difference was 0.0015, showing that there is a much smaller change in the density over the southern beds than over the northern.

DENSITY TABLE—POCOMOKE.

The figures show the excess of density over that of distilled water, which is represented by 1,000.

Bed.	Maximum Density.	Tide.	Remarks.	Difference.	Minimum Density.	Tide.	Remarks.
On and above Potter's and Slate Stone. ..	1.0160	H.W. and ¼ E.		.0047	1 0113	L. W.	Section.
Shell Rock and above...	1.0170	¼ Fl.	14 feet calms and light breezes several days.	.0014	1.0156	⅜ Fl.	5 ft. water.
Muddy Marsh.....	1.0174	⅜ E.	18 ft and same as above	.0014	1.0160	¼ Fl.	Strong easterly breezes.
Buoy Spit.....	1.0172	½ Fl.	15 ft. and same as above	.0004	1.0168	½ E.	15 ft. light breezes.
Bird Rock and Hern Island Rock.....	1.0175	½ E.	4 fms. & same as above	.0015	1.0160	⅜ E.	18 ft. mouth of Guilford Creek.
Mesongo Creek.....	1.0173	½ E.	17 ft. and same as above	0007	1 0164	L. W.	Eastward Station 7. feet.
Guilford Creek.....	1.0167	H.W.	9 ft. light breezes.	.0007	1 0160	¼ Fl.	Head of Creek.
Parker's Rock.....	1.0172	¼ E.	12 ft. light breezes.	.0009	1.0163	½ Fl.	Light breezes.
Brig Rock.....	1.0169	⅜ Fl.	11 ft. light breezes.	.0005	1.0164	L. W.	17 ft. light breezes.

CURRENTS.

Over the Pocomoke beds the general set of the ebb current is westerly until it reaches the shoal between and south of Broad and Apes Hole Creeks, where it turns to the southward into the main channel.

The majority of the observations of the ebb current were made during moderate northeasterly breezes but the direction seems to have been but little influenced by them, though the strength probably was, as at high and low water by the tide tables, when there should have been no perceptible current, one was observed of from 0.1 to 0.2 of a mile an hour. The maximum strength observed was 0.5 of a mile per hour.

The flood current sets northeast over the beds and has a maximum strength of 0.5 of a mile per hour and is but very slightly influenced in direction by the wind.

In the main channel of the Sound below the Shell Rocks and over the Muddy Marsh Rocks, the flood current sets to the northward, following the general direction of the channel.

The maximum strength of this current, when uninfluenced by the wind, was 0.45 of a mile per hour.

No observations of the strength of the ebb current were made in the main channel but it is probably equal, or of slightly greater strength, than the flood and sets to the southward. Over the Bird and Hern Island Rocks the flood current sets to the northward and eastward into Messongo and Guilford Creeks, with a maximum velocity, when uninfluenced by the wind, of 0.24 of a mile per hour. The ebb sets to the southward and westward, curving to the southward as it becomes influenced by the main current, with a maximum velocity of 0.4 of a mile per hour.

North of the Guilford Flats the flood sets northeasterly toward Muddy Creek. The maximum velocity observed during light northerly breezes was 0.3 of a mile per hour. South of the Guilford Flats the current follows the general direction of the channel, the flood having a tendency towards Hunting Creek, where the channel into Guilford Creek joins the latter.

The maximum velocity observed during light northerly breezes was 0.5 of a mile per hour.

The ebb out of Messongo and Guilford Creeks sets to the southward and westward, following the channel until it reaches the Bird and Hern Island Rocks, where it curves to the southward. Its maximum velocity was 0.4 of a mile per hour. The current over the Brig and Parker's Rocks sets to the northward and to the southward; the maximum strength of the flood, when uninfluenced by the wind, was 0.24 of a mile per hour, but a moderate breeze appears to be sufficient to cause a marked increase of strength and change of direction.

Off the mouth of the Chesconessex, where the wind, though light, had the width of Chesapeake Bay and both Tangier and Pocomoke Sounds to sweep over, the flood tide on the third quarter had a set to the northward and eastward of 0.4 of a mile per hour. North of Parker's Rocks the flood, on the first quarter, during a moderate southwesterly breeze, was found to set to the northeast at a rate of 0.6 of a mile per hour.

The oystermen greatly overrate the strength of the currents in the Sounds, putting the maximum velocity at about four knots on the ebb and somewhat less on the flood; but I could find no reason that would explain so great an increase over the velocities as established by ourselves, and consequently doubt the value of the estimate.

DEPOSITS.

The fact that on nearly all the beds and especially those in the vicinity of the creeks and rivers and in the upper part of the Sound, there is a light covering of mud more or less thick over the oysters, would lead to an inference that there must be a deposit of that character going on.

On most of the beds the substratum of the bottom was hard and the thickness of the surface covering gradually decreased as the entrance to the Sound was approached.

In the upper part of the Sound shells were found with the

mud for several feet and of such a number and character, being old and discolored, as to forbid the supposition that they had recently sunk in the mud or been covered by it.

The Pocomoke River, draining an extensive tract of the Peninsula, would bring down a large amount of sediment, which the strong ebb current would carry directly over the beds in the upper part of the Sound. The set of the ebb is east, and as will be seen by the chart, the deeper water lies nearest the southern shore of the upper Sound, and those beds lying to the southward of the channel are the hardest and least broken.

The shores are low and marshy and probably add somewhat to any sediment held by the main current before it enters the Sound.

I infer that there is a deposit going on of maximum amount over the Old Rocks and those to the northward of the channel and decreasing as the entrance to the Sound is approached.

The amount in any given period of time would be difficult to ascertain but the character will be shown to some extent by an examination of the specimens of bottom. Whether the amount of matter deposited is sufficient in quantity to seriously affect the beds is a matter of conjecture. I should judge that it was not and my opinion coincides with that of all the oystermen I was able to interrogate.

That it must have some effect cannot be doubted and the evident deterioration of the beds in Pocomoke Sound may be accounted for, to some extent, by the supposition that the effect is injurious; but so many other and more direct causes exist for the deterioration that it is difficult to eliminate their influence. The fact that the beds have existed and have been worked since the first settlement of the country, would lead to an inference that the effect, if prejudicial, was very slightly so.

The scattered oysters lying on the sands and those beds in the vicinity of sand-shoals and in shallow water, the Muddy Marsh and Beach Island Rocks particularly, are exposed to damage by "sanding" in a manner similar to certain beds in Tangier Sound and which has already been described. The

large amount of grass, sponge and sea weed, growing on the sand shoals, especially the one to the east of Herne Island and south of the Guilford Channel, is frequently torn up by the heavy gales and deposited on the beds with the same injurious effect that it had in Tangier Sound. Heavy southerly gales will sometime cover the beds above the Buoy Spit and Shell Rocks with mud for a short time but not sufficiently long, it is said, to affect the oysters seriously.

EFFECT OF ICE AND GALES.

The heavy gales that occur in winter and summer, though principally during the former season, increase or diminish the depth of water on the beds sometimes as much as three feet. Strong northerly and northwesterly gales have the effect of diminishing the depth of water by piling up any floating ice upon the leeward shores and cutting away parts of the shores. Heavy southeasterly and southerly gales will increase the depth of water on the beds, stir up the soft muddy bottom of the channels and beds above Shell Rock and during the winter, in addition to piling the ice on the leeward shores and planted beds near Ape's Hole Creek, will pile it up on the Old Rocks, Buoy Rock and Shell Rocks. Generally speaking, the beds in this, as in Tangier Sound, are in too much water to permit their being uncovered by even the heaviest gales, or to allow the ice to ground upon them at any time; but those beds in shoal water, of about one fathom and the planted beds, which are generally in less, are subjected to both. The effect of gales and ice in Pocomoke Sound seems to be less than that in Tangier Sound, in consequence of its less extent and small area.

GENERAL INFORMATION GIVEN BY OYSTERMEN.

The following information is that derived from the answers to the questions propounded to oystermen. All the oystermen and dealers that were encountered during the season, so far as was possible, were interrogated. That which was not

pertinent to the subject or evidently influenced by self-interest or other considerations, has been excluded.

There has been no material change of the channel within the memory of the oldest fishermen, nor have they ever found oysters in the deep water of the main channels of either Sound. With regard to the improvement or deterioration of the beds, it was the general opinion that the beds had been much extended in size, that the quality of the oysters had improved, both as to size and flavor, but that the number on the beds had been very materially diminished, so much so, that it was hardly profitable to work on some of the beds. About thirty years back, the large beds in the Sound were not known to the fishermen and when first discovered and worked, the oysters were in clusters, long and thin valved and of poor quality, though very numerous and easily taken. Since their discovery and especially during the last ten years, the beds have been greatly overworked and the number of oysters much lessened.

Formerly, the best oysters were found on the Terrapin Sands, and there were none on the sands in shore of the beds; now the finest oysters in the Sounds are found on the sands bordering on the beds and are considered better than any in the general market. All the beds have been much extended by dredging, especially the Bird Rock in Pocomoke Sound and the Great Rock in Tangier Sound, the former being two-thirds larger than when first discovered, and the three rocks, of which Great Rock was originally composed, having been dragged into one continuous bed. Though thus extended, it was the opinion that there were not as many oysters on the beds at present as were found on the smaller areas. Fishing Bay, at the northern extreme of Tangier Sound, though the beds as a whole had deteriorated, during the last four years there had been some improvement on account of a more rigid observance of "close time."

The cause assigned for the deterioration, and even the admittance of the fact, depended very much upon the occupation of the informant. The tongers, or those who pursued the fishery with tongs alone, were unanimous in

laying the deterioration to excessive dredging, while the dredgers, or those owning pungies or other vessels employed exclusively with the dredge, while they admitted the decrease in the number of oysters, laid such decrease to the action of natural and unexplained causes, arguing that the evident extension of the beds and improvement of the oysters, due to dredging, was sufficient to prove its good rather than ill effects.

In regard to the effects of ice in cold weather, every one coincided in the opinion that the oysters in deep water were most affected, and those in shoal or brackish water were least so. In the same depths and character of water, those oysters about the edges of "muddy rocks" and close to muddy channels or sloughs were most affected by the cold or a severe freeze. After the latter event the packers distinguish the deep water oyster by its dark, slimy appearance, and decline it, though at the same time shoal water oysters are in good order and are accepted. With regard to the quality of the animals, those in the Sounds were considered finer than those in the creeks and rivers, and of the different beds those from the Shark's Fin, Terrapin Sands and Bird Rocks were considered superior. Regarding flavor alone, those from the salt water were the best, and generally the salter the water the better the flavor.

In regard to an increased freshness of water, due to freshets and heavy rains, it was the general opinion that during the winter season it was not of much consequence, but that in spring or summer heavy rains or freshets were very beneficial, especially in the spawning season, hastening its advent and shortening its duration. An increased freshness of water always fattened the oyster. Oysters in salt water were always poor and oysters were generally poorer after a dry season. Planted oysters above Pig Point and the Old Rocks, in Pocomoke Sound, have been known to die from absorbing too much fresh water and those on the Old Rocks have sometimes suffered from the same cause, but this only occurs during heavy freshets.

With regard to the depth of water and character of bottom, shallow water was preferred, and sticky mud or mud and sand,

about six inches in thickness over a hard substratum, was considered the best, though a larger amount of mud did not matter, provided it was not so soft as to allow the oysters to sink in it and had a strong current over it.

The oysters were said to feed on the flood tide, having their bills open then and at no other time. No one had noticed any enemies or animals that preyed upon the oysters, and all seemed to be ignorant of the drills and their destructive effects.

The oysters are "culled," that is they are separated from the old shells and other *debris* while the boat or vessel is on or near the bed. Everything except the oysters is thrown back, sometimes striking the bed and as often the mud. The young oysters under a year and a half in growth and less than two inches long are also thrown back.

All persons interrogated were of the opinion that at least seventy-five (75) per cent. of the oysters on a bed are taken off each year and that no more than fifty (50) per cent. should be removed. Off the beds near Haine's Point, at least one hundred thousand (100,000) bushels, or about 20,000,000 oysters, were taken in the season of 1878. Off the Great Rock, about 100,000 bushels, or 15,000,000 of oysters, were taken by one hundred boats in October and November of 1877. The oysters on the rock at the end of November were so scarce that but a very small number of boats could find profitable work on the bed. In the spring about 75,000 bushels more were taken up and sent North, and as the oysters were small, they amounted to probably 15,000,000 at least. Exclusive then of the fishing done during the winter months, in one season it is estimated that 30,000,000 of oysters were removed from one bed alone.

Nearly all the oystermen advocated a "close time," either from April 1st or May 1st to October 1st; many considered a prolongation until November 1st, and an entire rest every other year, would be beneficial.

With regard to transplanting the oyster and its transportation all experienced persons were of the opinion that delicacy of handling, and freedom from jars, concussions and shocks

of any kind, was desirable. Oysters, when under hatches, have very frequently been killed by heavy thunder storms and firing of guns. Any concussion or sudden shock will prove destructive, if the animals are in a confined space. Oysters taken up during the summer are much more susceptible to injury from this cause than those obtained during the winter. Oysters are transplanted at any and all seasons but generally in the spring and autumn. Oysters obtained by the use of the "tongs" are preferred to those dredged, and generally those taken either before or after the spawning season are most desirable. The dredged oysters are apt to be broken about the bills, and will die on the planting grounds sooner and in larger numbers than the "tonged" ones. Those oysters planted about the Sounds are generally obtained from "tongers," but those sent to the North, being in such large numbers, are usually dredged. The size and age of the oysters to be transplanted depends on whether they are for early consumption or not. If the former, the larger and older the better, but in the latter case young oysters, from one to two years old, are preferred.

Generally any and all oysters are taken, without regard to age or size. The oysters for the Northern planting grounds are usually taken up as soon as ice clears away and are used during the spring. Those transplanted in the Sound are taken up later in the spring, or during the early summer or autumn months, and used during the following winter. Blunt-nosed oysters, with thick shells, do not thrive on the planting grounds. A change of bottom in transplanting oysters is not considered of so much importance as a change of water. The planted beds should be laid at the mouths of creeks and rivers having a rapid current. The bottom best for natural beds was considered best for planted ones.

The spawning season was said to be from May until August, inclusive, though most of the spawning was done in June and July. All opinions coincided that the oyster in shoal water spawned first, but differed as to whether the depth being the same, all oysters on the same bed spawned at or about the same time, as many being for as against the

theory. Currents were said to have no effect upon the spawning. Oysters of one year's growth, three-fourths of an inch long, have been seen with the spawn in them, and oysters on natural beds were thought by the majority to spawn sooner than the planted ones, though there was not much difference. Oysters transplanted with the spawn in them, however, will cease spawning.

A wet or warm spring would hasten the time of spawning, but would not shorten its duration. Heavy freshets were very destructive to the "spat" in Pocomoke Sound, driving it out into the Bay, and large schools of fish, especially trout and taylors, devoured a good many every spring and summer. The young were supposed to "strike" every three years, though there was but little regularity about it, a bed sometimes running for ten years with a young growth on it every year and then failing to produce anything for two or three years. Sometimes one part of the bed will be covered by young, and another part totally barren.

No systematic attempt had ever been made to increase the amount of "cultch" in the Sounds, though a few persons had placed old shells, ballast, boards and boughs about their planting ground and succeeded in making a good catch.

It was the general opinion that the oyster increased in size from one to two inches in the first year of growth and a little more than that during the second; afterwards the increase was much less. Oysters from two to four years old were considered as best for the market and are then from three to four inches long. Ten bushels of oysters were considered a profitable day's work for a tonger. For a dredger the number of bushels varied on account of their different sizes. About sixty bushels were considered a profitable day's work for the larger vessels and from twenty to thirty for smaller craft.

The dredging vessels employ from four to nine men and the "tonging" canoes one man and a boy. Tonging could not be carried on profitably in depths greater than four fathoms in the Sound and dredging in not more than six. The dredges vary in size, from two feet to four feet across the mouth

with from eight to sixteen teeth. Generally they are made about three feet wide, with twelve or fourteen teeth, but vary a good deal in weight. My informants found that generally speaking it was more profitable to fish with the tongs exclusively for the large oysters used for barreling by the dealers and to dredge for packing and canning establishments. The tongs are worked at small expense and the "barrel" oysters bring a much larger price, though they are necessarily selected oysters and more difficult to obtain. The prices paid during the season of 1877–78 were about one dollar per barrel for "barrel" oysters and from five to forty cents for the ordinary oysters from the beds; the "snaps," or most inferior quality, bringing the lowest price and forty cents being paid only for "extra culled" oysters. About twenty cents per bushel would allow a small profit. The flavor is not generally taken into account, and the degree of fatness and the size settles the price. Salt water oysters sometimes command better prices when intended for a special market or to supply some unusual demand.

With the improved appliances in use, as at present, the general opinion was that about twenty or twenty-five years ago one-third more oysters could have been taken in the northern part of Tangier Sound than at present, from two to five times as many about Crisfield, and in Pocomoke Sound nearly seven times as many as at the present day; that without any of the modern contrivances it was possible for either tongers or dredgers to take many more in a day than at present. The general opinion of all persons in and about the Sound, with very few exceptions, was that the beds were being worked much beyond their capacity and the majority were in favor of extending the "close time" as a remedy for the deterioration. Many thought that a resting time of a year or more would be beneficial. All were in favor of enforcing the law prohibiting the dredging and working of the beds during the "close time," and all testified that there was no attempt toward the enforcement of the law at present, either by the oyster police or any one else.

CONCLUSIONS.

The foregoing pages with the record and charts, contain all the data collected during the season for the study of the beds and the conditions affecting the animals upon them.

Not regarding it as within my province and not possessing sufficient knowledge of the subject, I have not attempted any study of the biology of the oysters but have confined my report to as concise a description as possible of the beds and conditions surrounding the various forms of life upon them. The following remarks are simply the conclusions drawn from certain peculiar features and facts established by the investigation and testimony and an attempt to account for them. In reviewing the remarks upon the different beds, it will be seen that there is a marked absence of oysters classed as "young," or those supposed to be of the last brood on all beds above Kedge's Straits in Tangier Sound, and above the Bird Rock in Pocomoke Sound. In Tangier, the young first appeared in considerable quantities on the middle of Muscle Hole Bed and Piney Island Bar. There were none in either the Manokin or Big Annemessex Rivers or on the northern part of Harris Rock, though large numbers were found on the central and southern portions of the latter. The southern beds of both Sounds were plentifully supplied. Again, on the southern beds there was a like absence of the class termed by us "young growth," or oysters apparently spawned during the previous season, while on the northern beds of both Sounds the proportion of this class was very large. Over these different beds the change of density is too slight to enter into the question and the currents too nearly similar, both in direction and strength, to have influenced the difference in production. On nearly all of the northern beds in both Sounds, the bottom is muddy or the beds in close proximity to muddy bottoms. To the southward, however, the bottom is hard and the beds surrounded by sand or gravel, except on the edges nearest the channels. Again, all the northern beds in both Sounds are in comparatively shoal water and those in the southern parts in deep water.

There are, then, two similar facts noticed in both Sounds with regard to the presence and absence of the young and "young growth;" the former have been found in deep water and on hard bottoms, the latter in shoal water, on or near soft bottoms. The character of the bottom can hardly be of much importance in this case, for though a hard clean bottom is necessary for a successful attachment of the "spat," yet the bottoms on the northern part of the Sounds must be sufficiently so to obtain a large quantity, as is shown by the large number of young growth on those beds and that the absence of the young is not due entirely to that cause is shown by their scarcity on the Chain Shoal and Drumming Shoal beds in Tangier and Shell and Muddy Marsh beds in Pocomoke Sound, where the bottom is hard and moderately clean. Remaining then as the only probable cause known to us is the difference of depth of water. It will be found upon reviewing the remarks and record, that almost invariably the young are found in deep water and the young growth in shoal. It was the opinion of the oystermen that the oysters in the Sounds increased from one to three inches in length in the first year of their existence. The class termed "young growth" by us were from three-fourths of an inch to one and a half inches long; and supposing the oystermen to be correct in their estimation of increase in size, the class termed "young growth" would then be of the same season's brood.*

The investigation of the beds was carried on in September, and in Tangier Sound; the principal amount of information was collected during the latter part of that month and the first part of October. If, then, the oysters on the shoal water beds had spawned in the early part of June, they would have had about four months growth when our observations were made. In searching for spawn in the oysters during the latter part of August and first part of September, Mr. Rice was unable to discover any except in those from deep water, and that fact, together with the inference drawn from the preceding paragraphs, leads me to believe the oystermen correct in stating

*Spawned much earlier than those termed "young."

that there is a difference in the time of spawning of the shoal and deep water oysters. There is but one other way of accounting for the absence of young on the northern beds, and that is by accepting the supposition that the "spatting" not only does not occur every year, but that it only occurs on parts of the Sounds during each season. Such is the opinion of many people of experience; but I am inclined, from the results already given, to prefer the other solution of the problem, not having found any reason that would support the opposite theory or lead to its entertainment.*

The difference in time of spawning in shoal and deep water is probably due to difference in temperature, the deeper water naturally being of the lowest. The establishment or the refutation of this supposition, as also of that of the difference of the times of spawning, is very necessary, especially of the latter, as it would afford a sure basis for such legislation for the protection of the beds as will soon be necessary. Aside from the general absence or presence of young on particular beds, it was noticed that a much smaller number were found on or adjacent to the muddy bottoms, or on the sands where there was much grass or sponge. On the beds a large number of young were seldom found where there was much of the red moss, though there was not always a diminution of the former when the latter was present.

The absence of the young may be very readily accounted for if the moss had formed previous to the "spatting," as it would prevent the exposure of the "cultch." The moss or weed is of very rapid growth, and I was informed that on an unworked bed it had been known to become three or four feet thick in a few months. If, then, it had formed and commenced growing after the "spatting" season, the young would not be as much disturbed by it as they would if the growth had been previous to their advent. This is another argument in favor of the theory that the depth of the water influences the time of spawning, as the effect of the moss or weed upon the numbers of young was greater in deep than in shallow water. The number of drills were, generally speaking, in direct pro-

*Note—Reference is made to this statement in Report of 1879.

portion to the number of young, and the Pocomoke beds, especially the Bird and Hern Island Rocks, appeared to have suffered most from their ravages.

A description and sketch of this animal, taken from specimens preserved by me, has been made by Mr. W. H. Dall, Assistant, who has kindly furnished me with copies. Very few star fish, and no other enemies were discovered in the Sounds, and the drills are probably the only ones that do any considerable damage.

In regard to the beneficial effect, or the reverse, of fresh water, there can be no doubt that the oysters at least appear fatter and are superior after absorbing it, though they become poorer in flavor.

In order to test the effect of fresh water upon them and to determine if the low spring tides had any share in causing the decrease in the numbers on the beds, a dozen oysters were selected from the same bed and haul of the dredge. Six of them were opened immediately and inspected and found to be rather poor, of small size, and dark color, but of the ordinary flavor. The remaining six oysters were placed in perfectly fresh water for twenty-four hours, the water being changed several times during that interval. They were then opened and inspected. They were alive and in good order, very fat, or apparently so, and of a creamy white color and much swollen, but of very insipid taste. As the oysters were alive at the end of a day's immersion in fresh water, they can not well be destroyed by the brackish water of low Spring ebbs, to which they would not be exposed for more than six hours, though a continuance of heavy freshets might very seriously affect them. As there is but one river in both Sounds (the Pocomoke) likely to subject the oysters to this evil, for the main beds there is nothing to fear.

The evil effects of sudden jars and concussions are probably due to the breakage of the delicate pedal muscle, which after the spawning season, in common with all other parts of the animal, is in a more or less weakened condition.

In explaining the fact that the oysters in deep water

are more affected by cold water and ice than those on the shoals, it is necessary to remember that the lower the temperature of sea water the greater its density, and thus as the surface water becomes cooler it would sink. The freezing point of salt water is below that of fresh. Therefore the oysters in the deep water, or generally speaking, those remote from the mouths of the streams, may have surrounding them water of a slightly lower temperature depending upon the amount of salinity than those oysters near the creeks and rivers that are surrounded by ice. Again, the deep water would be much slower to lose or acquire heat than that on the surface or in less depths, which would necessarily be affected quickly by all changes of weather.

The statement that the oysters recover and reappear after the "sanding" process, must be received with great caution, opposed as it is to most experience. That some few may survive is possibly the case, but that the majority recover after being covered with sand for any length of time is very doubtful.

The testimony of all persons in the neighborhood of the Sounds was to the effect that the beds were deteriorating. In the absence of any reliable observations, extending over any length of time, their opinions must be taken as correct, at least as to the fact, although perhaps only approximately so as to the degree. Accepting, then, the statement, it is necessary to account for the deterioration if possible.

After the original formation and growth of the beds they would at some time, the same conditions continuing, cease their development, neither increasing in size or in number of oysters, there being a natural limit to expansion in either direction. Supposing, then, a bed to have extended itself as far as the conditions of bottom and water or other natural limit would allow, all future expansion could be only in the number of oysters on the bed and this is limited principally by the amount of food and the room for development, the question of enemies not being considered, as there being no increase if they were not in sufficient numbers to prevent the growth of the bed and number of oysters, they would not be sufficient to cause its destruction or deterioration.

The number of oysters would then, on a limited bed, steadily increase, as long as there was sufficient room and food supplied them, until they had reached their limit, a rather indefinable one in that direction, the quality of the oysters not being taken into consideration. Having reached that point, the number of oysters would to all intents remain the same as long as the conditions under which they had previously lived were not changed. To cause, then, either an increase or diminution of the number of oysters or size of the bed, a new factor must be brought in, when, all conditions being changed, the life of the animals begins anew and progresses differently. As there can be no doubt that both the beds and oysters of Tangier and Pocomoke Sounds have changed greatly in character since their first discovery, in accounting for that change it is necessary to discover the new factor or factors that have been introduced, and that have been instrumental in effecting it. Briefly, the change in the beds has been a material expansion of their limits and a material diminution of the number of oysters upon them, and therefore the causes for such changes must be sought among such as it is known would produce like effects.

Disregarding for the present the agency of man in the matter, the question is what natural cause or causes would both expand the beds and diminish the number of oysters? A bed is extended naturally by the drifting spat or "young brood" attaching themselves to any clean, hard and moderately rough substance contiguous to the bed. The locomotive powers of the "spat" exist for but a short time and, except when assisted by the current, they can only move a short distance, and unless some suitable object soon presents itself for their attachment they will sink into the soft bottoms and die. The principal expansion of the beds so far as could be effected by nature must, however, have been accomplished long ago, the beds being surrounded originally, and indeed at present, by soft bottoms of a character which would be most destructive to the "brood," unless some substance was interposed between it and them for their reception. Natural expansion can only be achieved to any extent in the manner described, and though probably there is, and has been, a slow

extension of the beds due to natural unassisted causes, their great increase in area during the last thirty years must be assigned to other agents.

The diminution of the number of oysters may be affected by several natural causes. An increased deposit of earthy or vegetable matter upon the beds would, if in sufficient quantities to bury the oyster, effect the destruction of both old and young. No such deposit has been noticed, nor could it well occur without showing its presence in other ways, principally by changing the channels and causing shoals; but no such changes have occurred, my investigation showing but slight deviations in either channels, shoals or character of the bottom from that established by the first hydrographic survey of the locality. A change in the character of the water and bottom, which would probably follow a change of channel, and might occur without such change, might, by depriving the animals of their proper food, cause their deterioration and destruction. But such a change, though it would certainly diminish the numbers on the beds, would do so suddenly and the evil effects would be noticed in the oysters remaining, their quality and flavor, indeed, their vitality, being very much impaired. No such impairment has been observed, however, the oysters being larger and finer than when the beds were first discovered. That fact alone will eliminate many quantities from the equation, for any natural cause injurious to all the oysters on the beds would be evident at once by an examination of those found at present. If, however, the destruction or non-production of the necessary number of young is accomplished by means that are not harmful to the mature oyster, a cause is discovered for the diminution of all in harmony with the existing facts. Considering first the destruction of young; large numbers, immense when compared with the ordinary production of other animals, are without doubt naturally destroyed by the falling of the "spat" upon unfavorable grounds, the prevalence of heavy freshets which would drive the "brood" into the Bay, and probably cause its loss, and the ravages of various enemies. But all these causes have been in operation continually since the first formation of the beds, and the animals have survived

and increased while contending with them. Therefore an increase of power for injury must be assigned to one or all of these to account for the diminished number of oysters. Probably the "spat" falls on more favorable ground since the beds were discovered than was formerly the case, owing to the increased amount of "cultch" due to the fishing of the beds, and aside from that, the conditions surrounding and operating upon the beds are so similar to those in the past that the loss of the young could not be much greater from the want of attachment.

The freshets and other natural causes for diminished numbers of young have also been long in operation, and the deterioration cannot be justly assigned to them. Remaining then to be accounted for are the ravages of enemies. Those found by us during the season were drills in large numbers and a very few star fish, but as the oystermen were ignorant of both their presence and destructive effects, I am unable to decide whether they have increased or diminished in numbers. There is no doubt that very large numbers of young are destroyed by the drills; fully fifty per cent. on some beds in Pocomoke Sound. If, then, these small enemies have only within late years entered the Sounds, we have one of the principal causes for the deterioration of the beds. But as there is also a marked deterioration upon those beds upon which no drills were found, still another cause must be at work and must be sought in the non-production of the young. This is caused by the failure of the "brood" oysters, they having been removed or become extinct, thus causing a failure of impregnation. If the theory is correct that there is a mutual fecundation partaken of by all oysters on the beds, the spermatozoa being formed and milted somewhat prior to the formation of ova, then it can easily be understood that if the oysters are so much separated that even the tides and currents cannot bring the spermatozoa within reach of the adjacent animals, there could be no production of young. Taking for instance the most exaggerated case in both Sounds, that of the Muddy Marsh bed, it will be seen that the set of the current over it is not generally from any other adjacent bed,

the nearest one being Parker's Rock, which is over three miles distant; the oysters on the Muddy Marsh bed were very few and the mass of shells immense, affording ample surface for the attachment of the drifting "spat," should there be any. But supposing the oysters on the beds to have been so much diminished that they were not sufficient for mutual fecundation, the distance and situation of other beds is such as to prevent the current from bringing the spermatozoa voided upon them to the Muddy Marsh Rocks and there would be, as was noticed, an almost entire failure of young. In the same, though less degree, would the other beds suffer, the amount of spawn voided depending not only upon the number of mature "brood" oysters, but upon their distance from each other and the spaces separating the beds. This theory is supported by the investigations that have been made in England, France and Prussia, and almost all opinions coincide that the number of young in any spatting season is dependent upon the number of "brood" oysters upon the beds. Indeed, it seems so self-evident a proposition that it is hardly worth while to experimentally establish it. It is necessary, then, having accepted the theory, to determine what proportion of the oysters should be taken off the beds, and what proportion is actually removed. As there is no data to my knowledge derived from observations made in this country to determine the first of these two desired points, it is necessary to turn to the experience of foreign oyster fisheries for guidance, and though the animals and the conditions under which they live are not entirely similar, yet some information may be obtained and a line of investigation marked out for the future.

The following is a synopsis of the deductions of Professor Karl Möbius, Professor of Zoology in the University of Kiel, whose work on the oyster in manuscript was kindly lent me by Professor Baird. The observations were made over the Schleswig Holstein oyster beds by government officials from 1730 to 1852, and were carried on in practically the following manner. Each bed was dredged over in three or six places, according to its size, and the oysters taken were divided into three classes, and carefully counted. The classes were denom-

inated "marketable," "medium" and "young growth." The "marketable" oysters were full grown and mature, from seven to nine centimeters in length and breadth, and eighteen millimeters thick. The "medium" were half grown oysters, from sixteen to eighteen millimeters thick, and of less than nine centimeters in breadth. The "young growth" were those one or two years old. From these observations Prof. Möbius discovers that there was an average of 421 medium oysters to one thousand full grown ones; that is, out of every 1421 oysters there would be only one thousand full grown ones. (?) The average of all observations differ very little from the number given by each, and consequently shows that there was but slight fluctuation in the proportion in 122 years. The medium oysters are considered by Prof. Möbius to be those descendants of the marketable ones that have survived their most precarious years of existence, and escaped their principal enemies, and are consequently likely to reach their full growth. They thus represent the total number of embryos spawned which have survived in the struggle for existence. From his (Möbius') experiments, he decides that an oyster spawns about one million embryos in a season, and that forty-four per cent. of the mature oysters give forth "spat." [Other authorities are of the opinion that only about ten per cent. spawn; Prof. Möbius' data appears hardly sufficient to justify his conclusion.]

From the above it is evident that in an assemblage of a thousand oysters, 440,000,000 embryos can be voided every season, and of them 421 would survive, or 1,045,000 embryos would be destroyed where one was preserved. But the medium sized oysters also spawn, though they send forth a much smaller number of embryos. Möbius estimates that the 421 in the community would produce about 60,000,000 of "spat." It would therefore require about 500,000,000 embryos to produce 421 medium oysters, or 1,185,000 to produce one. From the above it is evident that it would be necessary to have 4.2 oysters assembled to produce one, though the proportion would only hold where there are much larger assemblages. Regarding these results, Prof. Möbius is of the opinion that no more

than 40 per cent. should be removed each year, but, in my opinion, in order to maintain the oysters at a constant number in the above case, no more than 25 per cent. should be taken, as the one oyster in four would be replaced each year. No comparison between the Schleswig-Holstein beds and those on our coast can well be instituted, as the beds in the Tangier and Pocomoke Sounds are of greater extent, and as the more extensive the bed the greater the breeding power, I should consider that until the annual number of mature oysters produced is known, it would be safer to take about 50 per cent. from the beds, supposing them to be in good condition. That is but an estimate, and may be an erroneous one, but certainly it is not too small, and it now remains to be seen what number of oysters are actually removed from the beds. I regret that statistics of the oyster trades in the Sounds are not at hand for reference, and also that the pressure of other work while I was in that locality prevented me from obtaining them. Such observations as I was able to make, however, will furnish a basis for a somewhat rude estimate of the number of oysters and young taken off the beds during the season. While in Crisfield harbor, about the 11th October, there were counted fifty-seven sail oyster dredges, and the number of bushels carried by them estimated, and the estimate verified by the subsequent statements of the masters of the several vessels in each class. The following table shows the result:

TABLE I.

Class.	Number.	No. of Bushels.	Average No. of Bushels.	Class of Vessel.	Number.	No. of Bushels.	Average to sail.
Schooners.....	37	2075	56	Buckeyes.....	4	45	11
Sloops.....	12	256	21	Canoes.....	4	32	8
Total.....		2331		Total.....		77	
		77					
Grand Total...		2408					

The day had been a bad one for dredging, and but a small number of dredgers had been at work, and they had come into port much earlier than usual, consequently the average and total number of oysters are below the usual figures. On the same day, in order to ascertain the number of young attached to the mature oysters that were taken off the beds, I had three samples, of a peck each, selected from different vessels entering the harbor, and the number of young on the shells counted. The vessels were of different sizes and from different localities. The results are shown in the table following:

TABLE II.

Vessel.	No. Bushels.	No of Young to the Peck.			Bushel Average.	Localities from which obtained.
		1st.	2d.	3d.		
Sloop.....	13	13	....	.....	72	.
Schooner ..	30	93	125	163	508	The small proportion from Great Rock, the large from Terrapin Sands.
Buckeye	15	33	....	.....	132	Deep Water Rock, Kedge's Sts.
Sloop	23	73	88	.....	322	Paul's Rock.
Schooner....	90	76	78	.....	308	Great Rock.
Schooner....	65	32	67	.....	192	
Schooner....	80	55-	89-	57-40	221	Great Rock and Thoroughfare.
Buckeye....	10	1	....	.....	4	Paul's Rock (Sands).
Buckeye....	25	49	....	.....	196	Great Rock (northern part).
Schooner....	50	64	39	23	168	Great Rock.
Schooner....	150	67	35	.....	205	California Rock.
Total					2228	Average 202 per bushel.

The total number of bushels brought into Crisfield, as seen by table number one, amounted in one day to 2408, and estimating the number of oysters to a bushel to be between 150 or 200, we have for the results of one day's fishing from 361,200 to 481,600 oysters, and about 486,000 young. During the progress of the work in the Sounds, there were twenty-four counts made of the dredgers in sight from the vessel. In order that some idea may be formed of the number of oysters taken by these dredgers, an estimate has been made, based

upon table number two, of the number of bushels and young carried off the beds. In forming the estimate, all the vessels in the Sound were divided into three classes. The first being an assemblage of all the different craft, the second only the smaller classes, and the third, where about two-thirds were small, and the remainder large craft. The number of sail counted were then placed in one of these classes, we having observed when among the dredgers the particular class and size of vessel usually working over a particular ground. In order to ascertain the number of bushels to each vessel, the total number of bushels brought in [2408] was divided by the number of sails [57], which would give forty-two bushels as the average to a sail. A closer estimate is obtained from table No. 2, where the number of bushels assigned to each craft is that given by their master. The total number of bushels [551], divided by the number of sail [12], gives forty-five and a fraction as the number of bushels to each sail. I have divided by twelve instead of eleven, because the last number in table No. 2 was the result of two days' dredging.

The average number of bushels per sail for the second class, by table No. 1, is 16.6 bushels; by table No. 2, 17 bushels. The average for the third class is by table No. 1, 29 bushels; by table No. 2, 33 bushels. In all cases the smaller numbers have been used in calculating the number of bushels of oysters. The total number of bushels taken from the beds in both Sounds in thirteen days was 47,842, and allowing from 150 to 200 oysters to a bushel (though the number is probably larger), there would be removed from the Sounds in the very first of the season from 7,176,300 to 9,568,400 oysters. This, however, is far below the real number, as the entire area and number of sail were not visible at the same time.

In order to estimate the number of oysters removed from the beds in each day, I have divided the Sounds into four sections. The first section comprises all of Tangier Sound north of Little Island and the Muscle Hole Bed. The second section comprises all of that part of the Sound, including Manokin and Big Annemessex rivers, between Little Island and Jane's Island. The third section comprises all of

Tangier Sound south of Jane's Island. The fourth section all of Pocomoke Sound.

Assembling the number of dredgers known to have been dredging on these different sections, and the number of bushels taken by them, I have deduced the following results:

Locality.	1st Section Upper Tangier.	2d Section Middle Tangier.	3d Section Lower Tangier.	4th Section Pocomoke.
Total No. bushels taken (in)	15,135	10,115	18,060	* 2,673
No. of days	4	4	6	3
Average per day	3,783	2,523	3,060	891
Average No. Oysters per day	567,450	378,450	459,000	133,650
Grand Total taken off in one day				1,538,550

* 150 oysters are given to the bushel.

Though there were dredgers in large numbers at work early in September, and also many during the entire summer, yet in order that any error may be under, rather than over estimation, I will consider the working season to be from the first of October to the first of May, and allow three days in each week for bad weather which would prevent dredging. That allowance will leave 120 working days, and in that time, by the preceding table, over 184,600,000 oysters would be removed from the beds in the Sounds, supposing them to supply the same number during the entire season. By table No. 2 it will be seen that the average number of young to a bushel was 202. That number represents the number of young oysters attached to the shells of the full grown ones that were removed from the beds. That the estimate is not above what is actually the case I am certain from the immense numbers of young brought up by our own dredging operations. In making up the estimate twenty and thirty young were frequently found on one shell, and in one case fifty-four were counted. In estimating the total number removed from the beds in one day,

only those vessels dredging on such beds as were known to have a large proportion of young upon them have been considered, and even then the estimate reaches the astonishing figure of 1,238,790. These oysters are those of from two to five months growth, and may be said to have survived the most precarious portion of their existence, their shells having become hard enough to resist the drills to a certain extent, and they being firmly attached to the mature oyster, and in no danger of destruction from any cause to which it would not be equally exposed. Still many of them would doubtless perish even if undisturbed, for though all oysters on the beds mature, or others, would suffer if exposed to unfavorable conditions, yet many of those conditions would affect the young and young growth to a greater degree than the mature and more hardy oysters. I will, therefore, suppose that fifty per cent. of the young taken up would never have reached maturity, and will also make another and very liberal supposition that by the first of April the young would have reached such a size as would make it profitable to open them. That would make the working season, so far as the young were concerned, 104 days, and the number of young removed would amount in that time to 128,834,000, of which about 64,417,000 would probably have attained their full growth.

These young are a total sacrifice, never seeing the water again after their removal and generally perishing on distant or adjacent shell heaps. Many more are probably destroyed by carelessness in disposing of the old shells brought up by the dredge. The dredging is usually across the bed, and the shoal hard ridges noticed along the edges of the beds on the western side of Tangier Sound and on all edges adjacent to muddy bottoms, are, no doubt, caused by the dredgers who, as they approach the edge of the bed, having dragged across it, haul in their dredges just before getting over the muddy bottoms. They then stand on tack or "wear" and as soon as on the bed drop the dredges again.

In the meantime the crews have been busily "culling" the oysters, and, as likely as not, have thrown over on the soft mud a far larger number of young attached to the shells than

they have taken off on the oysters. No account has been taken of the number of mature or young oysters removed by the tongers, and the estimates are based upon observations made at the commencement of the fishing season, when the prices being low, a smaller number of dredgers would be at work; therefore, there is every reason to believe that the estimate of both classes of oysters is under, rather than above, the real number removed. We have then, aside from the ravages of the drills, a yearly destruction of over 64,000,000 young, and the removal of 184,600,000 mature spawning oysters to account for the deterioration of the beds. Whether this extensive fishing is beyond the capacity of the beds or not cannot be accurately stated; the only information on the subject obtainable being the statements of the oyster-men, that the beds are deteriorating from that cause. But an estimation of the effect of excessive fishing may be formed by examining its results upon such beds in England and France as have records upon the subject. The most instructive of these are the records of the production of the beds of Cancale Bay, on the northwest coast of France, which extend over a period of sixty-eight years—from 1800 to 1868. The beds in the Bay comprise an area of about 150 acres, and from 1800 to 1816 produced from 400,000 to 2,400,000 a year. This, however, was the period of the Napoleonic wars, and the fishing was much disturbed by the presence of the English cruisers. During this time the beds became so thickly stocked that the oysters were in some places a yard thick. After the close of the war the fishing improved and the oysters were removed in larger and increasing numbers until 1843. From 1823 to 1848 it is supposed that the dredgers were living upon the oysters accumulated during the period of enforced rest, from 1800 to 1816. In 1817 the number of oysters produced was 5,600,000, and until 1843 there was a constant increase, the number taken in the latter year being 70,000,000. In 1848 it was 60,000,000; thenceforward there was a constant decrease. From 1850 to 1856 the decrease was from 50,000,000 to 18,000,000, supposed to be the effect of over-dredging. From 1859 to 1868 the decrease was from 16,000,000 to 1,079,-

000; the oysters having almost entirely disappeared from the beds, though on account of the suffering condition of the inhabitants of the shores it was almost impossible to prevent it. In 1870 there was a complete wreck of the bottom, which could only be remedied by a total prohibition of the fisheries for several years. From the beds of the districts of Rochefort, Marennes and island of Olévon, on the west coast of France, there were taken in 1853 and 1854 10,000,000 oysters, and in 1854–5 15,000,000.

On account of exhaustive fishing in 1863–4 only 400,000 could be obtained. According to the testimony of Mr. Webber, Mayor of Falmouth, England, about 700 men, working 300 boats, were employed in a profitable oyster fishery in the neighborhood of Falmouth until 1866, when the old laws enforcing a "close time" were repealed, under an impression that owing to the great productive powers of the oyster it would be impossible to remove a sufficient number to prevent the restocking of the beds. Since 1866 the beds have become so impoverished from excessive and continual fishing that in 1876 only 40 men and 40 boats could find employment, and small as the number is, they could not take more than 60 or 100 oysters a day, while formally, in the same time, a boat could take from 10,000 to 12,000. According to the statement of Mr. Messum, an oyster dealer, and secretary of an oyster company at Emsworth, England, made before the Commission for the Investigation of Oyster Fisheries in May, 1876, there were in the harbor of Emsworth, between the years of 1840 and 1850, so many oysters that one man in five hours could take from 24,000 to 32,000. In consequence of overfishing in 1858, scarcely ten vessels could find loads, and in 1868 a dredger in five hours could not find more than *twenty oysters*. The oyster fisheries of Jersey, in the English Channel, afforded employment to 400 vessels. In six or seven years the dredging became so extensive and the beds so exhausted that only three or four vessels could find employment, and the crews of even that small number had to do additional work on shore in order to support themselves.

The foregoing are a few of, though by no means all, the in-

stances that may be quoted in order to show the disastrous effects of over-working the beds, and in concluding the remarks under that head, it will be instructive to extract from Professor Möbius' work his prophecy with regard to our own beds, which is here introduced:

"In North America the oysters are so fine and so cheap "that they are eaten daily by all classes. Hence, they are "now, and have been for a long time, a real means of subsist- "ance for the people. This enviable fact is no argument "against the injuriousness of a continuous and severe fishing "of the beds. * * * * But as the number of consumers "increases in America the price will also surely advance, and "then there will arise a desire to fish the banks more severely "than hitherto, and if they do not accept in time the unfor- "tunate experience of the oyster culturists of Europe they "will surely find their oyster beds impoverished for having "defied the bioconotic laws."

The question now to be decided is how the protection of the beds and their improvement is to be brought about. The protecting laws of the State of Maryland, which govern the larger part of the Sounds, are briefly as follows: Dredging is allowed from October 1st to May 1st. Taking of oysters in other ways from September 1st to May 1st. Dredging is not allowed in the rivers and creeks of the Sounds or in their mouths. No steam dredgers are allowed. All dredgers and "tongers" must be licensed. Violations of the law are punished by not more than two years imprisonment nor $200 fine. For the enforcement of these regulations there is established a State Fishery Force, consisting of one steamer and several small sloops; one of the latter having jurisdiction over Tangier and Pocomoke Sounds. The officers of this Fishery Force and the sheriffs and constables of the different counties are empowered to make arrests and enforce the law.

The above is the amount of protection afforded by the law if carried out. In the Sounds, in reality, there is none. Neither the State Fishery Force, sheriffs, constables, or any other persons make arrests or enforce the law; the public opinion of the community being against such a proceeding, though every

one recognized the necessity when considered in the abstract. I have seen numbers of dredgers at work and the police boat cruising among them, and this was during the latter part of August, when, if at any time, the oysters should have been free from disturbance. Before deciding upon the measure of protection to be given to the beds, it may be well again to see what has been accorded by foreign governments, and with what success. On the Schleswig-Holstein banks the "close time" is from the 9th of May to the 1st of October; no oysters less than two and a half inches in length are removed at any time. The law is enforced, and still the beds are deteriorating. In Ireland the "close time" is from May 1st to September 1st, and in some localities of the coast from the 1st of April and the 1st of March until the 1st of October and the 1st November. It is unlawful to dredge or have in possession any oysters or oyster brood during the "close time."

The Inspector of Fisheries can call a meeting of interested persons to decide upon a change of "close time." Inspectors are empowered to permit the planting of oysters and to prohibit the presence of dredgers on board any boat during the close time. The coast guard and constabulary are empowered to enforce the laws, and violators are suitably punished. The deep sea fisheries for oysters in the English Channel are governed by rules adopted by England and France. The close time is from the 16th of June to the 31st of August. Any boat having a dredge or other implement used for taking oysters during that time is considered as having violated the law. Competent courts of each country have power to punish offenders, and the cruisers of each nation power to enforce the law, which is strictly observed by the French fishermen and frequently violated by the English. In France the oyster beds are protected by stringent and effective laws, which may be briefly stated as follows: The government assumes control over all oyster banks and foreshores. As occasion may seem to require, an entire bank or part of it may be reserved from dredging for a certain time, decided by the local commission. The general practice seems to be to buoy off a third or fourth of a bank each year, which

portion is only sufficiently dredged to remove weeds, mud, vermin, &c. The remainder of the bed is opened to all licensed persons for a certain specified time. The following year another part of the bank is reserved, and occasionally parts are reserved for a longer period. The local commission decides all matters pertaining to the beds and their vicinity, and is composed of the following officers: The Inspector of the Fisheries, the Commander of the Fishery Guard, two "Gardes-Maritimes, one fisherman, master of a boat. The following are the most important regulations made for the guidance of the Commissions by the Minister of the Marine: The beds should not be opened for fishing until the spat has acquired strength to resist the action of the dredge: until the end of January, for example. When a bed has well established breeding capacities a fourth or fifth part of its total area should be set apart as a reserve, and dredging over such part entirely prohibited. A Fishery Guard boat should, whenever practicable, take part in the working of each bed. When a bed is foul or encumbered with weeds or other matter noxious to the development or adherence of spat, it should be open for dredging until cleaned. Beds on which there is never any production of spat shall be opened all through the season. After the working of any bed is over, it should be carefully inspected, and if necessary, the cultch replenished. The close time is between the 1st of May and the 31st of August, and is strictly observed. The foregoing regulations have caused a great improvement in the beds on the French coast, and the regulations of other nations have been made and enforced in time to prevent the depletion of their beds.

As an instance of the effect of this protective policy, when understandingly conceived and rigidly enforced, the beds in the Bay of Arcachon are a good example. In 1870, through over-fishing, they had become entirely exhausted, but by the strict protection afforded them their fecundity has once more become so great (in 1876) that the waters of the Bay from June until August are filled with the young swarm. On a bed when dry, at low spring ebbs, comprising 26.7 acres, there were taken by 40 or 50 persons, in about two and a half

hours, 60,000 oysters. That part of the bed was immediately buoyed, and no more fishing allowed during the season.

Having then seen what is considered necessary for the protection of the beds by European nations, and why it is necessary, the question is how we can best use their experience. The best remedy for any evil is the removal of the cause, and the beds in Tangier and Pocomoke Sounds are suffering from over-dredging and the destruction of the young brood. Until the rate of production and the proportion between the number spawned and the number reaching maturity is decided, only a specified number should be taken off of each bed in the Sounds. If observations, both as to the number removed and the increase or decrease of the proportion to the square yard were continued, a basis might be found for the establishment of the maximum number to be removed. Until that number is established no working of the beds should be permitted between the middle of April and the first of November, and none of the beds in Pocomoke Sound should be dredged over at all, except so much as it is necessary to clean them. There should be a sufficient number of oyster guard-boats to superintend the dredging, both in general and when for cleansing purposes; to collect statistics as to the number of young and mature oysters removed, and to make all observations as to the proportion to the square yard. They might also collect a good deal of useful information while on the beds. During September and October they should examine the beds, in order to ascertain the number of young, and those beds having a large proportion should be reserved from dredging operations until the young are able to resist the action of the dredge. No oysters below a certain size should be taken off the beds, and it should be punishable to have those under the specified size in possession. Whenever it is judged that any bed open to general fishing is being worked beyond its capacity, the oyster guard should have power to prevent any further dredging on it. When any bed with a large number of young upon it is open, either the packers or fishermen should be compelled, as far as possible, to return the shells to the beds, or the hard bottoms surrounding them, within a cer-

tain specified time, provided that the oysters were opened in their immediate vicinity. Large numbers of young would thus be saved and the areas of the beds increased. No one should be allowed to take or to possess an oyster having more than a specified number of young attached to it. During the time when not otherwise employed the oyster guard-boats could be usefully engaged in removing the weeds and grass from the sand shoals, and the moss from the closed beds. It must be remembered that dredging is not an unmixed evil, and that the improvement of the oysters and the extended areas of the beds are mainly due to it; but it should be conducted under suitable restrictions, and in this connection may be advised the use of the scrape where it is now prohibited, and the prohibition of the heavy dredges in shoal water and on the soft bottoms.

If there is any animal known to naturalists that is an enemy of the drill and not harmful to the oyster, its introduction into the Sounds would be a great benefit, and finally, if in the spring either the State or the fishermen would collect the shells from the piles about the packing houses and deposit them on the hard bottoms contiguous to the beds, they would furnish an excellent "cultch" for the "spat," and probably make a good catch and a permanent extension of the oyster ground.

I have made the above suggestions with the hope that they may in some way bear fruit for the benefit of those engaged in the oyster fishery in the Sounds and Bay. Some more adequate protection than that now offered must soon be afforded or loss and distress among the large number of people in Maryland and Virginia engaged in the fishery will soon follow from the failure (and that more or less sudden) of the oyster industry. In concluding this part of my report, I cannot do better than to again quote Prof. Möbius, whose remarks on the preservation of natural banks of oysters are well worthy of attention:

"In conclusion, I hereby give as the foundation for all "oyster culture the most important rules for the improvement "of the natural oyster banks.

"First. An oyster bank will yield permanently the greatest "profit if it possesses such a stock of full grown oysters as "will be sufficient to maintain the fecundity of the bank in "accordance with its bioconotic conditions.

"Secondly. When the natural conditions will admit of it, "the yielding capacity of an oyster bed may be increased by "improving and enlarging the ground for the reception of the "young brood. The natural banks should be improved by "removing the weeds and plants with dredges and properly "constructed harrows, and by scattering the shells of oysters "and other mussels over the bottom. When circumstances "will permit, all the animals which are taken in the dredge, "and which kill the oysters or use up their food, should be "destroyed. It would be much more judicious and much "better for those who eat oysters if the 'close time' could be "extended until the 15th of September or the 1st of October, "so as to allow the oysters some time after the expulsion of "the contents of the generative organs to become fat before "being brought to the table. If it is desired that the oyster "banks should remain of general advantage to the public and "a permanent source of profit to the inhabitants of the coast, "the number of oysters taken from the beds yearly must not "depend upon the demands of the consumers or be governed "by high price, but must be regulated solely and entirely "by the amount of increase upon the beds. The preservation "of the oyster beds is as much a question of statesmanship as "the preservation of forests."

AREAS OF OYSTER BEDS.

Name of Bed.		Area. Sq. Yards.
Fishing Bay Beds	(Solid)	3,600,000
" " "	(Scattered)	25,605,000
Were Point Bed	(Solid)	1,845,000
Shark's Fin	"	1,867,500
Nanticoke Beds	"	3,465,000
Clump Point	"	382,500
Horsey's Bar	"	202,500
Tyler's Rock	"	675,000
Drumming Shoal	"	2,430,000
Cow and Calf	"	292,500
Bed East of Bloodworth Island	"	4,027,500
Cedar Rock	"	337,500
Turtle Egg Island Rock	"	1,620,000
Mud Rock	"	1,845,000
Chain Shoal	"	1,192,500
Muscle Hole	"	3,060,000
Piney Island Bar	"	6,975,000
Manokin River Beds	"	6,142,500
Big Annemessex	"	2,835,000
Harris' Rock	"	3,420,000
Terrapin Sands	"	1,417,500
Paul's Rock	"	765,000
Woman's Marsh	"	6,975,000
Rock Off Jane's Island Light	"	1,800,000
Great Rock	"	8,505,000
Little Thoroughfare	"	720,000
Great "	"	1,597,500
Oak Hammock Rocks	"	630,000
California Rock	"	3,915,000
Johnson's Rock	"	1,395,000
Brig Rock	"	517,500
Parker's	"	495,000
Beach Island	"	225,000
Hern Island	"	2,092,500
Bird Rock	"	3 285,000
Guilford Creek Rocks	"	1,642,500
Messongo	"	180,000
Muddy Marsh	"	1,912,500
Buoy Spit	"	427,500
Small Rock South of Shell Rock	"	225,000
Shell Rock	"	877,500
Trevise Rock	"	697,500
Drum Bay Point Rock	"	337,500
Dog-Fish Rock	"	720,000
Flat Rock	"	742,500
Small Rock North of Trevise	"	135,000
Slate Stone Rock	"	967,500
Potter's Rock	"	900,000
New Plantation Rock	"	180,000
Buoy Rock	"	967,500
Old Rocks	"	1,057,500

AREAS OF OYSTER BEDS.

Tangier and Pocomoke—Summary.	Sq. Yards.
Total area in both Sounds occupied by oysters	425,012,500
" " " " " " solid oysters beds	92,520,000
Ordinarily Scattered	313,345,000
Thinly "	19,147,000

		Nautical Sq. Miles.
Tangier Sound	(Solid)	17,101
" "	(Scattered)	44,926
Pocomoke Sound	(Solid)	4,519
" "	(Scattered)	29,599
Fishing Bay	(Solid)	875
" "	(Scattered)	6,225
Total area both Sounds covered by oysters, or scattered oysters, in *square miles* (nautical)		103,255

Note.—Those areas designated as "solid" are those where the proportion to the square yard fell below 0.1, or below one oyster to ten square yards.

PART II.

Extracts from Report of Investigations made from July 4th to October 20th, 1879.

The work of the party under my charge was properly the collection of such information as would conduce to the correct answers to the following questions:

1st. Were the oyster beds improving or deteriorating?

2d. What were the causes for such improvement or deterioration?

3d. How is the deterioration to be prevented or the beds improved?

In the endeavor to answer these questions it was necessary to investigate many problems and to collect much information having apparently but little bearing upon the main question, but it was my endeavor to limit the extent of the inquiry as much as possible and to direct all the energies of the party to the decision of the three points mentioned.

Though the biology of the oyster should be studied, yet only so much of it was essential to the work we had undertaken as would assist in the solution of the problem presented, and consequently it was desirable to leave an extended investigation in that line to others and to settle ourselves only such points as would, so far as we could see, directly assist us in arriving at correct conclusions.

The investigation conducted during the summer and autumn of 1878 had shown that the beds were deteriorating rapidly, and so far as could be seen the principal cause for this deterioration was the over-fishing of the beds. The remaining question to be answered was then, how the deterioration was to be prevented.

The main cause, as I have said, was decided to be excessive fishery, which, by removing too large a number of mature brood oysters, diminished in a constantly increasing ratio the fecundity of the bed. Other causes operated also to some extent, but their effects were inconsiderable.

There is but one method of maintaining the fecundity of the beds, and that is by protection, but this protection can be afforded in several ways: Either by restricting the fishery, by enlarging the field for the dredgers, or by insuring the maturity of a larger number of oysters, by artificially impregnating the ova of the female and protecting the resultant embryos during those periods when they were unable to protect themselves.

To afford protection and maintain the fecundity of the bed in the last mentioned manner has been attempted by Dr. W. K. Brooks, and his efforts have been in a measure successful. The ova has been impregnated, and the life of the resultant embryos has been maintained for varying periods, the maximum being six days.

Whether this success will be of practical benefit remains a matter of conjecture, and should it prove practicable to thus assist nature in maintaining the beds at their greatest productiveness, it will require extended experiments before we can feel assured that the protection afforded in this manner will be sufficient. To confirm the opinion as to the deterioration of the beds, and to show the best method of protecting them in the two remaining ways has been the endeavor of the party under my command, and to that result have our efforts been directed.

In the absence of positive and correct information as to the life and habits of the oyster, all legislation relating to their protection must be to a great extent inoperative and non-productive of the desired results, and until such information has been obtained the best and easiest remedy for the deterioration would be an extension of the known fishing ground; in other words, the discovery of new and well stocked beds, as the number of dredgers being, at least for a few years, constant, they will naturally seek the most profitable field for

labor, and leave the overworked beds for the newly discovered ones, thus giving the former a chance for recuperation. That this is the case is evident by the record of statistics, most of the dredging vessels working on the new beds outside the Sound and on those in the Potomac River on account of the poor returns given by the beds in Tangier and Pocomoke Sounds.

The protection afforded in this manner would, however, be but temporary, the demand for oysters constantly increasing, and the number of vessels working liable to increase with it. It may soon be necessary to legislate for the direct protection of the beds and to limit the supply by law before it is stopped entirely by nature It is well, therefore, for the best interests of all classes that such an amount of information should be collected, as to the character of the beds and oysters and the general conditions under which they advantageously live, as would direct protective laws into a channel productive of most good.

The first necessary information to be obtained, and of greatest moment, would be a knowledge of the positions and areas of the beds. No law could well be passed which would protect a bed whose position and boundary was not at least approximately known, nor could any study of separate beds or comparisons of many be undertaken without such knowledge. Again, since nature has already selected these areas as those most favorable to the growth and life of the oyster, they evidently are the best grounds upon which to deposit the young brood, should the experiments of Dr. Brooks prove successful and of practical importance.

It is hardly possible to enumerate all the advantages of knowing the positions and areas of the natural beds, and indeed it may safely be said that a thorough study of the oyster question would be impossible without it.

Of next importance is the knowledge whether at any time the bed is in a condition of greatest fecundity.

In the attempt to attain this knowledge the proportion of oysters to the square yard of the surface was ascertained during the season of 1878, as described by me in my previous

report. The results were of comparative value, and subsequent operations in each year were to show whether the oysters on the bed were increasing or diminishing, or in other words, the fecundity of the bed, as compared with previous seasons, was to be ascertained.

During the last season these proportions have been again calculated in a similar manner, but working with a greater knowledge of the subject generally, and a more correct estimate of the desired results, I have devised another method for ascertaining whether the bed is in its most productive condition.

It is evident that in any large community, when at its greatest fecundity, there must be certain ratios between the individuals of different ages, and that any change in these ratios will indicate an increased or decreased fecundity.

It was not, and probably will not be for some time, possible to separate the oysters into classes by ages, except in a very rude manner. The only indication of the age is the size of the animal, and the oysters were, therefore, separated into four classes, according to size, in the following manner:

The first class contained all those over three inches in length, and embraced all full grown, mature oysters.

The second class contained oysters between two and three inches in length, and these were supposed to be mature and fit for market, and between two and three years of age.

The third class contained oysters between three-quarters of an inch and two inches long, and represented the young growth of the preceding seasons, being thus oysters from six months to two years of age.

The fourth class contained all oysters under three-quarters of an inch in length, embracing the most minute that could be recognized, and represented the young growth of the last spawning season, or those of less than a year's growth.

By obtaining a sufficient number of each class from each bed it was intended to establish ratios between each class, which compared with ratios on new and comparatively unworked beds, would show whether the particular locality under examination was in a state of greatest productiveness

or not, and by comparing the ratios of successive seasons, the increase or decrease constant or otherwise, could be ascertained, and the yield of the bed in ensuing seasons predicted.

In order to have another and more correct standard for comparison, and to arrive at certain conclusions as to whether the spatting in any season was general and extending to all beds or confined to particular localities, and in order to know accurately the number of oysters surviving each period of their perceptive existence, numbers of spat collectors were deposited upon the different beds.

It was the intention to frequently inspect these tiles, and by counting the number of oysters on each tile at each examination the number of oysters surviving would be ascertained, and the age of the previously established classes would be decided.

Thus the life of a community of oysters, free from the dredging influence and protected from all but natural enemies, would be before us from the time of the first attachment until they reached maturity.

The study of their embryological life properly belonged to the zöological student, and the method of propagation and the successive stages of that life must be left to him to determine It is valuable to the inquiry under consideration, but not essential, as it is evident that we may neglect the early stages of life, and yet arrive at correct conclusions as to the number of mature oysters necessary to support the beds in their best condition.

In next importance to the knowledge of the absolute fecundity of the bed, is a knowledge of those conditions which would influence it, and in order that no cause for the deterioration should be neglected, and that all information bearing in any way upon the propagation and growth of the oyster might be collected, several matters of secondary importance have been subjected to investigation and the results embodied in either this or my previous report.

Included under this head are—

Investigations into the temperatures and the influence of

increased or diminished temperature upon the mature oyster and embryos.

Investigations into the character of the water, especially as regards its increased or diminished density and its extent.

Investigations into the character of the bottom and its influence upon the oyster.

A determination of the direction and velocity of the currents, and such collection of statistics of the oyster trade and fishery as would show its present condition and give a value to the dredging factor; and, lastly, a collection and study of the *fauna* of the beds, particularly of those animals supposed to affect the oyster.

An attempt has also been made to collect the experience of the oystermen and dealers, as to the habits of the oysters and as to the effect of the various changes of environment.

Having shown what, in my opinion, were the objects to be obtained, and the direction which the investigation should pursue, it remains now to describe in detail the work of the party in each branch of the inquiry and to decide upon the value of the results.

DELINEATION OF THE BEDS.

The beds in Tangier and Pocomoke Sounds were surveyed during the season of 1878 and described in my report of the operations of the party during that year. During the last season the survey of the beds has been but an incidental part of the work, only such having been delineated as time and circumstances would permit.

Those lying inside the Sounds have been subjected to an examination and survey similar to that of the previous season.

BEDS IN THE NANTICOKE RIVER.

These are small and inconsiderable, embracing a total area of 827,025 square yards.

Most of them lie on the eastern side of the channel and extend a short distance above Ragged Point, though detached groups may be found much further up the river.

The beds are small and the oysters and shells uniformly

spread over each surface. Each bed is very hard, and in most cases the probe would not penetrate beyond six inches.

When it was possible to push through the surface stratum a sub-stratum was found of sand.

The main part of the river bottom is of mud, and bottom of that description surrounds the beds. Along both shores the mud is firmer and of greater consistency than in the channel, and above Roaring Point and on those bottoms are placed large numbers of oysters transplanted from the Middle Ground bed and from other localities.

The river seems to be a favorite planting ground, and numbers of boats and canoes were working the Middle Ground bed during the summer in order to obtain the "plants."

The oysters are small, single, and in small clusters, and not of very good quality.

The water being shoal, from five to ten feet, no dredging could be done on these beds, and consequently the proportions to the square yard have not been calculated.

BEDS IN THE LITTLE ANNEMESSEX.

There are only a few small beds in this river and they are very seldom worked. Their total area is 463,951 square yards.

The oysters are in detached groups, separated by spaces of mud and sand, and are small, single, and in small clusters.

The depth of water varies from six to twelve feet.

BEDS IN KEDGE'S STRAITS.

The bottom of Kedge's Straits, from the sands on one shore to those on the other, is covered with scattered oysters to greater or less extent, but they are found in greater numbers in the channel on the soft bottoms than elsewhere.

The total area of the beds is 2,893,615 square yards, and three of them are of considerable size.

The first lies on the northward side of the Straits, north of Solomon's Lump Light House, south and southwest of the Western Islands.

It extends in a W. N.W. and E. S.E. direction (that of the

channel), and is 1¼ miles long and from one-eight to one-half mile broad, and is irregular in outline. Its area is 1,243,580 square yards.

Due west of this bed, south of Oyster Creek and N. N.W. of Fog Point is the second bed. It extends north and south five-eighths of a mile and east and west one-third of a mile. Its area is 645,705 square yards.

Southwest and west from this bed, and northwest from Fog Point, in the middle of the Straits, and west of the shoals, is the third bed. Its area is 550,045 square yards, and its greatest length N. N.W. and S. S.E. is three-fourth mile, with an average breadth of one-fourth mile.

The depth of water on the inner bed is from 12 to 16 feet, and on the two outer ones from 14 to 19 feet.

The oysters are spread in groups of different areas, separated by spaces of mud and sand, generally the latter, except close to the channel-way, where there is more mud.

The beds are in almost all cases very hard; when the probe would penetrate, however, soft sand was found.

The inner bed is much softer than the other two, and has a larger amount of mud.

The oysters were small and dark, single, and in small clusters of three or four, with no red sponge or grass.

On the outer beds the shells were lighter and cleaner than on the inner, and generally the oysters in the Straits are larger and with sharper bills than those inside.

INVESTIGATION OF THE CHESAPEAKE BAY WEST OF TANGIER AND SMITH'S ISLANDS.

The only information with regard to the ground outside the Sounds that could be obtained was, that there was a number of beds of different areas lying in the Bay, on the eastern side of the ship channel, especially about and on the shoals off Smith's Island and Kedge's Straits.

The ground being so little known, and the accurate delineation of the beds being so difficult when attempted with a sailing vessel, I considered it better to employ the limited time at my disposal in running tentative lines, off and on shore,

and other crossing lines over the ground, with a view to discover the location of the beds, and to mark these localities for a more thorough and exhaustive investigation in the future.

As it was then your intention to continue the investigation and delineation of the beds, I thought it preferable and a saving of time and labor to search for them first and afterwards survey them.

In accordance with this plan I dredged over the bottom of the Bay, from Tangier Island northward, running the lines sufficiently close to detect any beds of importance or the presence of scattered oysters.

The distance over which the dredge was dragged was always measured, and when the depth of water was not too great, the bottom was probed with a view of determining whether it was suitable for the oysters.

By reference to the projections it will be seen that these areas occur quite frequently on the shoal ground making off in a southwesterly direction from Tangier Island. That between Tangier Island and Cheesman's Islands there are, in the deep water, no oysters, and that from abreast Cheesman's Islands as far north as the investigation extended, there were found large areas upon which oysters were living, and in some cases in great numbers.

The depth of water does not appear to influence the formation or growth of these beds, some of them lying on the shoals and others in deeper water. Generally speaking, here as in the Sounds, the original beds were formed on the side of the shoals and wherever there was a sudden change of bottom.

Wherever the solid beds or "Rocks" were encountered they were found to be long and narrow ridges, extending generally in a northerly and southerly direction, except when near Kedge's Straits, where they ran more to the eastward and westward.

We could, in standing across the beds, but rarely obtain more than one or two hauls of the dredge before we were off the "Rock." The major axis appears here, as elsewhere, to lie in the direction of the current, and probably all natural

extension and growth of any bed is in that direction, the spat being carried backward and forward by the ebb and flow of the tides.

The large number of beds near and off Kedge's Straits is probably due to the large number of spat brought out from the Sounds through the Straits.

The bottom is generally of hard sand covered with sponge and grass. Near Kedge's Straits some mud sloughs were found, and in some cases the sub-stratum of the beds was of clay, but in most of them the stratum of oysters and shells was too thick and hard to be penetrated.

The beds outside the Sounds have been comparatively free from dredging, and thus present marked differences from those inside.

They are comparatively longer and narrower, and much more sharply defined. Very few scattered oysters are found near them, and the beds are much more solid, unbroken, and much harder, requiring heavier dredges than those used in the Sounds.

The most remarkable difference is, however, in the shape and growth of the oysters.

On the undredged beds they are long and narrow, with the lower shells very deep, and bills very thin and sharp. In no case did we find any single oysters of any class. All grew in clusters of from three and four to twelve and fifteen. The shells were clean and white and free from mud and sand. Generally there was found a tuft of red or white sponge attached to the clusters, and the mature first and second class oysters were covered, and the interstices between them filled.

With those of the third and fourth classes numbers of barnacles were also found, and some *crepidula*, but *tubicola* were only present in small numbers.

The oysters found upon beds that have been much worked differ materially, being single and broader, in comparison to their length, round and with blunt bills. They are usually dark in color, and have a considerable amount of mud and sand on the shells. The sponges do not appear to be as abundant, and the amount of dredging on any bed may always be known by the appearance of the oysters brought up.

Upon an over-dredged and almost exhausted bed the oysters will be large and single, blunt-billed, with dirty shells, and an almost entire absence of sponges, barnacles and *crepidula* will be noticed, but the shells will be covered with *tubicola* and bored in many places by the *boring pholad.*

Late in the last spring the dredgers began working on the beds immediately off Kedge's Straits and the one off Hog Neck, and during the present season the returns show that the beds in the Sounds have been, to some extent, abandoned for those outside in the Bay.

As so little dredging was done before my examination, I think the results of the dredging operations of the party may be considered as obtained from unworked beds. These results will be alluded to subsequently.

Probably small beds will be found along the shores of the islands from Kedge's Straits to the entrance of Tangier Sound, but as the water was shoal I could not dredge very close in.

As far as can be seen at present there is no reason why the existing beds should not be extended very considerably, and such extension will probably take place now that the dredgers are beginning to work upon the beds. If suitable cultch is exposed, probably very large areas will soon be covered with oysters.

TABLE OF PROPORTIONS TO SQUARE YARD.

Locality.	No. of observ.	Proportions.
Section 1, West of Kedge's Straits	40	0.371
" 2, " Red House	7	0.439
" 3, " White House	11	0.296
" 4, " Hog Neck	28	0.399
Mean of observations		0.375

The above table of proportions to the square yard has been compiled from all observations made in the Bay, when there was any evidence of a bed existing, such evidence being given by the probe, soundings, and character of the matter brought up by the dredge.

The proportions have been calculated in a manner similar to that described in my previous report, and are, as was pointed out in that report, only of value as forming a standard for comparison. It must be borne in mind, however, in making such comparison, that the hardness of the unworked beds and the closeness of the growth of the oysters would prevent as many being taken by the dredge as on the softer and more open beds in the Sounds.

By referring to the table, it will be seen that the proportion calculated for each locality is very nearly the same as that arrived at by combining all the observations, and that this proportion is about 0.4 to the square yard.

Accepting that as the standard, the proportion to the square yard upon a bed which has been dredged for some time should certainly not fall below 0.4, and considering the different characters of the bottom, the proportion, as shown by the dredge upon an old bed, should be much larger, unless the bed has been overworked.

The following table shows the number of oysters of each class examined, and also the number of bushels brought up and the percentage of shells and debris to the whole amount.

As will be seen by the table, the number of the fourth class of this year's growth is very large, showing that however bad the season may have been inside the Sounds it has not influenced the reproduction in the Bay.

DREDGING RESULTS. CHESAPEAKE BAY. Table No. 1.

Locality.	Number Dredges.	1st Class.		Ratios.	2d Class.		Ratios.	Number of Section.	3d Class.		Ratios.	Fourth Class.	No. of Bushels Dredged.				No. of First-Class Oysters to the Bushel.
		Oysters.	Bushels.		Oysters.	Bushels.			Oysters.	Bushels.			Total Amount.	Bush. Oysters.	Bush. Debris.	Ratio Debris.	
West of Kedge's Straits.....	52	1018	8.8	1.49	1622	4.7	0 17	Sec. 1	1150	2.6	2.32	2674	23 7	16.1	7.6	0.32	115
West of Red House.....	12	359	3.0	1.00	360	1.0	0 88	" 2	318	0.7	1 41	447	7.2	4.7	2.5	0.34	115
West of White House.....	15	135	1.1	1.07	145	0.4	0.16	" 3	23	....	2.15	50	3.	1 5	1 5	0.5	115
Hog Neck Rock.....	106	1997	17.3	1.29	2579	7.5	1 08	" 4	2779	6.4	1.87	5200	42 2	31.2	11.0	0.26	115
West of Tangier Island.....	15	37	0.3	1.30	48	0.1	1.06	" 5	51	0.1	3.74	191	2.2	0.5	1.7	0.77	115
	200	3546	30.5	6.15	4754	13 7	3.87		4321	9.8	11.49	8562	78.3	54.0	24.3	0.31	
Mean of Ratios.....				1.23			0.78				2.29						

0.75 per cent. of this year's growth.

In the foregoing tables the ground dredged over has been divided into parallel sections, and all oysters from the beds in those sections have been assembled together.

Section 1 includes all the beds west of Kedge's Straits.

Section 2 the beds west of that position on the chart marked Red House.

Section 3 the beds west of that position marked White House.

Section 4 the beds west of Hog Neck and Cheesman's Islands, and Section 5 the beds west of Tangier Island.

In compiling the tables I have entered only those hauls of dredges that have been taken on the beds or when the oysters were in considerable numbers. The scattered and detached groups and single oysters have not been considered.

Section 5 is not an important one, owing to the very small areas of all the beds encountered on it.

By examining this table it will be seen that a total of 54 bushels, amounting to 21,183 oysters, were examined; that from 200 hauls of the dredge we obtained 78.3 bushels of oysters and shells, and that 31 per cent., or 24.3 bushels of this matter consisted of shells or other debris.

This percentage does not differ materially from that found on each section.

Section 5 is not considered, as the percentage there does not entirely represent shells and other debris of the bed, but rather the sponge and grass of the sand shoals.

Regarding these beds as in their natural condition of healthy life, it is inferred from the deduced table that, other things being equal, a larger percentage of *debris* would indicate that the bed was not giving, for the same amount of labor, its natural return, or, in other words, that the mass of old shells brought up by the dredge was out of proportion to the number of oysters.

This percentage is of value as indicating the most profitable working grounds, and also as indicating, when very large, that the bed has been overworked and its population destroyed, as the percentage of shells bears the same relation to the oysters as the unoccupied dwellings in a city do to its in-

habitants; an increased percentage means a decreased population.

It is evident that there should be a certain proportion between the oysters of different ages, and in general terms the number of young should exceed the mature, thus allowing for the natural depletion in each period of growth.

Our present knowledge, however, is not sufficient to allow the assignment of exact values to these proportions, and the ratios between the different classes are too irregular, owing to the variations in the spawnings in the several seasons, to allow their acceptance as a standard.

One thing, however, may be assumed as an axiom, and that is that the number of young growth on a bed should always exceed the mature oysters, for if there are no young oysters in the community there will soon be no old ones, and as there is a constant depletion of each class, the young must sufficiently outnumber the old ones to allow these ravages and still adequately supply the demand and fill up the vacant places in the higher classes.

An inspection of Table 1 will show—

1st. That 0.75 per cent. of the 4th class were of this year's growth.

2d. That the ratios between the 3d and 4th classes are the largest, and between the 2d and 3d classes the smallest.

As the 2d class represents oysters of between two and three years of age, and, as the ratio between the 2d and 1st classes is large, I judge that there was a successful spatting on these beds in 1876; and as the 3d class represent, on the whole, oysters of the season of 1877 and 1878, and as the proportion between those of that class and those of the second is small, I infer that the seasons of 1877–78 were bad spawning ones.

Again, the 4th class are principally of this year's growth, and the ratio of 4th to 3d class is large, from which I infer what was the case, that the spatting of the last season on these beds was successful.

As already explained, the 3d and 4th classes practically represent the offspring of three successive spatting seasons, and thus contain the young growth on the bed, while the 1st and

2d classes represent the mature oysters. If, then, we compare the mature with the young, we have at once a sure indication of the state of the bed so far as its fecundity is concerned.

In order that the areas under consideration might be as similar as possible to the extensive beds inside the Sounds, I have only used for the following table the three largest sections—Nos. 1, 2 and 4:

DREDGING RESULTS. CHESAPEAKE BAY. TABLE I.

LOCALITY.	No. of Section.	Oysters. 1st & 2d.	Oysters. 3d & 4th.	Ratios.
West of Kedge's Straits	Section 1	2,640	3,824	1.06
" Red House	" 2	719	765	1.06
Hog Neck Bed	" 4	4,576	7,979	1.70
		7,935	12,568	
Mean of Ratios				1.58

Accepting this mean ratio of all young growth to mature oysters, upon comparatively unworked beds, as the standard, it is inferred that it should not fall below 1.5 or 1.6.

FECUNDITY OF THE BEDS IN THE SOUNDS.

In order to ascertain whether the fecundity of the beds in the Sounds was the same as that of those outside in the Bay, a very thorough dredging was continued during the summer and autumn, and the oysters classified according to the plan already described.

The dredging lines are shown on the sketches accompanying the report, and were run over all beds where it was possible to carry the vessel.

The results are assembled in the following table:

DREDGING RESULTS TANGIER SOUND. Table I.

Locality.	No. Dredges.	1st class. No. Oysters.	1st class. No. Bushels.	Ratios.	2d class. No. Oysters.	2d class. No. Bushels.	Ratios.	3d class. No. Oysters.	3d class. No. Bushels.	Ratios.	4th class. No. Oysters.	Bushels Dredged. Total Amount.	Bush. Oysters.	Bush. Debris.	Ratio Debris.	No. of 1st class Oysters to a Bushel.
Middle Ground Nanticoke	1	17		5.18	88		1.06	93		0.43	40					
Shark's Fin	57	382	2.9	1.28	489	2.3	0.92	453	1.6	0.92	418	10¼	6.8	9.4	0.58	246
Were Point	34	340		0.91	311		0.77	241		0.59	142	6				
		722			800			694			560	16¼				
Tyler's Rock	14	102	0.5	1.45	148	0.4	0.39	59	0.2	0.49	29	3½			0.72	
Horsey's Bar	2	15		1.06	16		1.37	22		1.14	25	½	1.1	2.9		
		117			164			81			54	4				
Drumming Shoal	39	666	3.	2.16	1439	4.20	0.91	1303	3.	0.47	607	12.5	10.2	2.3	0.18	220
Cow and Calf	6	51	2.8	0.66	34	1.6	0.68	23	1.3			1.				
Grass Tangier	65	417		1.25	520		1.06	554		1.06	586	14¼	5.7	9.5	0.62	163
		468			554			577				15¼				
Turtle Egg Island	54	375	2.3	2.4	900	2.6	1.57	1419	3.2	0.54	770	16.	8.1	7.9	0.50	
Mud Rock	53	521	3.2	3.03	1580	4.6	1.34	2121	4.9	0.52	1115	21.	12.7	8.3	0.40	

DREDGING RESULTS TANGIER SOUND. TABLE I—Continued.

LOCALITY.	No. Dredges.	1ST CLASS.			2D CLASS.			3D CLASS.			4TH CLASS.	BUSHELS DREDGED.				No. of 1st class Oysters to a Bushel.
		No. Oysters.	No. Bushels.	Ratios.	No. Oysters.	No. Bushels.	Ratios.	No. Oysters.	No. Bushels.	Ratios.	No. Oysters.	Total Amount.	Bush. Oysters.	Bush. Debris.	Ratio Debris.	
Chain Shoal	47	330	1.6	1.09	359	1.0	3 55	1374	3.1	0 70	966	21.	5.7	15.3	0.72	
Piney Island Bar	211	1282	6.2	3 0	3850	11 3	2 56	9857	22 8	0 41	4070	75.2	40.3	34.9	0 45	204
Muscle Hole	97	1176	7.2	2.34	2752	8.0	1.68	3876	9.0	0.48	1876	45.	24.2	20.8	0.46	
Manokin River	93	881	4.6	1.41	1282	3.7	0 48	2158	5.0	0 49	1169	26.2	13.3	12.9	0.49	188
Big Annemessex River	41	392	2.0	3.88	1521	4.4	1.21	1846	4.2	1.03	1905	29.2	10.6	18.6	0.63	196
Harris' Rock	108	559	2.7	3 11	1740	5 1	2 97	5174	11 9	0.62	3204	21.0	19.7	1.3	0.06	
Terrapin Sands	54	426	2.8	2.26	996	2.8	2 18	2110	4.8	0.61	1292	26.0	6 4	19 6	0.75	
Jane's Island	17	150	0.8	5.23	784	2 3	3.53	2771	6.4	0.43	1209	14.5	9.5	5.0	0.34	
Woman's Marsh	127	852	7.4	1.13	968	2.8	2.30	2229	5.1	0.42	947	65	15.3	49 7	0.76	115
Great Rock	152	1408	8.0	1.89	2665	7.8	3 02	8056	18.6	0.51	4153	116 5	34 4	82.1	0.70	176
Little Thoroughfare	35	82	2.2	2.32	190	1.8	3.69	702	10.9	0.49	346	6.5				
Great Thoroughfare	33	230		1.90	438		9.15	4010		0.36	1483	16.	14.9	7.6	0.33	140
		312			628			4712			1829	22.5				
California Rock	82	663	3.3	0.93	620	1.8	1.75	1085	2.5	0 71	767	24.	7.6	16.4	0.68	196
Johnson's Rock	18	39	0.2	1.38	54	0.1	1.20	65	0.1	0.92	60	2.	0.4	1.6	0.80	

DREDGING RESULTS POCOMOKE SOUND. Table I.

Locality.	No. Dredges.	1st class. No. Oysters.	1st class. No. Bushels.	Ratios.	2d class. No. Oysters.	2d class. No. Bushels.	Ratios.	3d class. No. Oysters.	3d class. No. Bushels.	Ratios.	4th class. No. Oysters.	No. of Bushels Dredged. Total Amount.	Bush. Oysters.	Bush. Debris.	Ratio Debris.	No. of 1st class Oysters to a Bushel.
Dog Fish Rock	32	213		0.68	145		1.12	163		0.65	107	11.5				152
Trevise Rock	1	14	2.2	2.14	30	0.7	1.10	33	0.4	0.91	30	1.				
Shell Rock	31	88		0.42	37		0.38	14		1.78	25	31.	3 3	33.7	0.91	
Flat Rock	16	44		0.81	36		0.50	18		0.44	8	5.				
		359		0.69	248		0.91	228		0.74	170					
Muddy Marsh	22	59	0.3	0.2	12	0.03	0.75	9		1.67	15	14 2	0.3	13 9	0 97	
Bird Rock	60	237	1.2	0.19	46	0.1	0.37	17		3.23	55	50.	1.3	48.7	0.97	188
Hern Island Rock	39	180	1.0	0.34	61	0.2	3.62	221	0.5	0.16	36	23.	1.7	21.3	0.92	178
		417		0.26	107		2.22	238		0.39	91					
Parker's Rock	22	154	1.2	0 99	153	0.4	5.85	895	2.0	0 33	296	14.2	3 6	10.6	0.74	120
Brig Rock	23	166	1.3	0 57	89	0.2	1.07	95	0 2	0.52	50	77.	7.7	6.9	.77	120

By referring to Table I it will be seen that on all the beds in Tangier Sound, from Fishing Bay down to the Great Rock, with one exception, that of Chain Shoal, the maximum ratio is that of the second class to the first. The inference is that there was a successful spatting season on all the upper beds in 1876 or 1877, probably the former.

Again, the minimum ratio, as far down the Sound as the Mud Rock, is that of the third class to the second, showing that on the beds above the Mud Rock there was not a successful attachment in 1878, which was the case as attested by ourselves. The remaining ratios on these beds show that there has been some attachment during the present season.

Leaving the Chain Shoal Bed for the present, the minimum ratio on all the remaining beds is that of the fourth class to the third, showing that there has been but little attachment of young during the season of 1879.

The remaining ratios show that there was a partial attachment of young on the beds between Turtle Egg Island Rock and the Great Rock during 1878, and a partial attachment on the remaining beds north of Jane's Island during 1876 or 1877, while there was a successful spatting on those lower beds during 1878, which conclusion was found to be correct by our observations during that season.

Arranging these deductions in tabular form, we have the following:

TABLE *showing the success of Spatting in different Seasons—Tangier Sound.*

Year.	Section No. 1. Upper Tangier Beds down to Mud Rock.	Section No. 2. Middle Ground, Turtle Egg Is., to Great Rock	Section No. 3. Lower Tangier, below Jane's Island.
1876 or '77	Successful.	Successful.	Moderately successful
1878	Unsuccessful.	Moderately successful	Successful.
1879	Moderately successful	Unsuccessful.	Unsuccessful.

The Chain Shoal differs from the beds of its section, the upper, in having its successful spatting season in 1878, and its moderately successful one in 1876 or 1877, while during

the last season there has been but a small attachment; it thus assimilates itself to Section 3.

If Table I is again referred to for the Pocomoke Beds, it will be found by assembling the upper beds under one head and considering the Bird and Hern Island Rocks to be what they practically are, one bed, we have a table for Pocomoke, as follows:

TABLE *showing the success of Spatting in Different Seasons—Pocomoke Sound.*

Year.	Upper Pocomoke.	Muddy Marsh.	Bird and Hern Island Rocks.	Barker's and Brig Rocks.
1876 or 7..	Unsuccessful	Unsuccessful	Unsuccessful	Moderately successful
1878..	Successful	Moderately successful	Successful	Successful.
1879..	Moderately successful	Successful	Moderately successful	Unsuccessful.

With regard to these tables, it must be remembered that the success or want of it is only by comparison with previous years, nor does it necessarily mean that there has been even a moderate attachment, but only that one year was better than another.

By combining the 1st and 2d classes and 3d and 4th on each bed, and combining such beds as are similarly situated and contiguous, I have arranged the following table for comparison with the similar one of the dredging results on the beds in the Bay:

DREDGING RESULTS TANGIER AND POCOMOKE SOUNDS.

TABLE No. II.

NAME OF BED.	OYSTERS. 1st & 2d.	OYSTERS. 3d & 4th.	Ratios.
Shark's Fin	871	871	1.0
Were Point	651	383	0.58
	1,522	1,254	0.82
Tyler's Rock	250	88	0.35
Horsey's Bar	31	47	1.51
	281	135	0.48
Drumming Shoal	2,105	1,909	0.90
Cow and Calf	85	23	0.25
Grass Tangier	937	1,140	1.21
Turtle Egg Island	1,275	2,189	1.71
Mud Rock	2,101	3,236	1.53
Muscle Hole	3,928	5,752	1.46
	8,326	12,340	1.48
Chain Shoal	689	2,340	3.41
Piney Island Bar	5,132	13,927	2.71
	5,821	16,267	2.79
Manokin River	2,163	3,327	1.51
Big Annemessex	1,913	3,751	1.96
Harris Rock	2,299	8,378	3.64
Terrapin Sands	1,392	3,402	2.44
Jane's Island	934	3,980	4.26
Great Rock	4,073	12,209	3.00
	5,007	16,189	3.23

The ratios underlined thus (.....) are the only ones considered, and show the proportion of young growth to mature oysters in each locality.

DREDGING RESULTS TANGIER AND POCOMOKE SOUNDS.

TABLE No. II—Continued.

NAME OF BED.	OYSTERS. 1st & 2d.	OYSTERS. 3d & 4th.	Ratios.
Woman's Marsh	1,820	3,176	1.74
Little Thoroughfare	272	1,048	3.85
Great Thoroughfare	668	5,493	8.22
California Rock	1,283	1,852	1.44
Johnson's Rock	93	125	1.34
	2,316	8,518	3.67
Dog Fish Rock	358	270	0.75
Flat Rock	80	26	0.32
Trevise Rock	44	63	1 43
Shell Rock	125	39	0.31
	607	398	0.65
Muddy Marsh	602	24	0.04
Bird Rock	283	72	0.25
Hern Island Rock	241	257	1.07
	524	329	0.62
Parker's Rock	307	1,191	3.87
Brig Rock	257	145	0.56

The ratios underlined thus (.....) are the only ones considered, and show the proportion of young growth to mature oysters in each locality.

I find the ratio of young growth to mature oysters to be, generally speaking, a constantly increasing one from the head of Tangier Sound to the last section.

In my report of the investigation carried on in 1878, I called attention to the noticeable absence of "young" on the beds above Piney Island Bar and Kedge's Straits, and to the large attachment on the southern beds, and the ratios in Table II begin increasing materially on those beds where there was a successful attachment of young during the previous season.

Referring to the "Spatting Table," it will be seen that on the upper section there has not been a successful attachment since 1876 or 7; hence, the mature oysters from two to three years old, the growth of those seasons, should be in the ascendant naturally, and, hence, the small ratios on the upper section.

Apparently the ratios should be about the same on the middle section, as its successive spatting season was also in 1876 or 7; but the moderately successful season was in 1878, while on the upper section it was in 1879; and as brood oysters are constantly taken from the beds in constantly increasing numbers, it follows that the yield of each succeeding year will be less. As an additional cause, more of the beds in the upper section are worked during the summer than in the others.

During the season of 1878 there was an extraordinary growth of young on Harris' Rock, which accounts for its large ratio, and the increase of the other ratios over those of the first section is due, to some extent, to the attachment of the season of 1878.

On the lower section the ratios are very large, by reason of the successful attachment in 1878, and the but moderate success of the seasons of 1876 or 7.

The variations in the ratios can thus be accounted for by the success or failure of different spatting seasons, and no doubt this success or failure has its influence, but that its effects are not invariable can be seen by reference to the ratios of Pocomoke Sound.

With the exception of Parker's Rock, a small bed lying near Watt's Island, and which has not been dredged upon as

extensively as the others in Pocomoke Sound, we find the ratio of young growth to mature oysters exceedingly small. In no case do the former predominate. From this, according to the deductions from the Tangier Beds, it would be inferred that the seasons of 1876 or 7 were unusually successful ones for the attachment of the spat, and that subsequently there has been no successful season.

By referring to the spatting table, we find, however, that the spatting season of 1876 or 1877 was, on the whole, unsuccessful, and the seasons subsequent have either been successful or moderately so, and this conclusion is supported by our observations during 1878.

But as the success or non-success, as shown by the spatting table, is comparative only, we can only assume that whether successful or not the attachment was not sufficient as one explanation of the small ratios found in Pocomoke.

Consequently the variation in the success of different spatting seasons is not sufficient to explain unusual and abnormal changes in the ratios of the young growth to the mature oyster.

It is evident that the removal of a large number of mature oysters from a bed would show apparently an increased fecundity, by increasing the ratio of young growth to mature oysters, and this apparent increase would be observable for at least two years, or until the young growth became in turn mature, when, as the reproduction would naturally be diminished by the removal of the brood oysters, and consequently there would be a smaller number of young growth, and as the young growth of the previous year would be in that time mature, the ratio would suddenly turn in the opposite way, and be as abnormally small as it had been abnormally large.

Once having taken this turn, and the fishing still continuing, the ratios would constantly decrease. A few fluctuations might occur now and then, but the general tendency would be a diminishing one.

Nature arranges her own laws of supply and demand, and the proportions she establishes between the different classes in any community are most likely to be the necessary ones, and

such proportions are the only ones that can be accepted as standards.

We have established that upon the unworked beds in the Bay the ratio of young growth to mature oysters is about 1.5, but as this is the result of but one season's observations, and those over a somewhat limited area, it would be rash to accept that standard exactly or to draw rigid inferences from comparison with it.

In order to allow a sufficient margin for the variations of different seasons and localities, it will be better to consider the normal ratio as between 1 and 2, and, hence, any increase or decrease of those ratios will be an indication of diminished fecundity, and, consequently, all things remaining the same, the eventual destruction of the beds.

Comparing the ratios of the beds in the Sounds with that established as a standard, we find that—

1st. All beds above the Grass Tangier fall below the minimum ratio.

2d. That the groups including Tangier Grass and Muscle Hole are within the limit, as are the beds in the Manokin and Big Annemessex Rivers and the Woman's Marsh Rock.

3d. That all other groups exceed the maximum ratio.

4th. That all beds in Pocomoke, with the exception of Parker's Rock, are below the minimum.

Instituting another comparison, that of the percentage of debris to the total amount brought up, we find that with the exception of Drumming Shoal and Harris' and Jane's Island Rocks, the percentage constantly increases to the southward, and that in Pocomoke it is larger than elsewhere, and larger on the Muddy Marsh and Bird Rocks than on any others.

A coincidence will here be noticed in the increased ratios in lower Tangier and the increased percentage of debris, and, in Pocomoke, in the small ratios and very large percentage of debris.

TABLE OF PROPORTIONS TO THE SQUARE YARD—TANGIER SOUND.

Name of Bed.	No. of Hauls of Dredge.	1878.	1879.	Differences.
Horsey's Bar	6	.....	0.254	.....
Tyler's Rock	12	.....	0.529	.....
Were Point	50	1.254	0.840	—.414
Shark's Fin	80	1.014	0 328	—.686
Drumming Shoal	57	.....	0.994	.....
Tangier Grass	100	1.064	0.372	—.692
Turtle Egg Island	55	0.382	0.295	—.087
Mud Rock	52	0.642	0 515	—.127
Chain Shoal	41	1 539	0.242	—.296
Piney Island Bar	198	0.687	0.544	—.143
Muscle Hole	87	0.826	0.746	—.080
Manokin River	90	0.134	0.320	+.186
Big Annemessex River	41	0.560	0.665	+.105
Harris' Rock	109	0.281	0.423	+.142
Terrapin Sands	51	0.271	0.423	+.152
Jane's Island	14	.....	0.670	.....
Woman's Marsh	110	0.240	0.125	—.115
Great Rock	151	0.165	0.265	+.100
Little Thoroughfare	35	0.145	0.104	—.040
Great Thoroughfare	32	0.115	0.236	+.121
California Rock	79	0.212	0.261	+.049
Johnson's Rock	17	0.187	0.074	—.113

TABLE OF PROPORTIONS TO THE SQUARE YARD—POCOMOKE SOUND.

Name of Bed.	No. of Hauls of Dredge.	1878.	1879.	Differences.
Upper Pocomoke Beds	79		0.139	
Muddy Marsh	20	0.405	0.070	—.335
Bird Rock	58	0.360	0.124	—.236
Hern Island Rock	39	0.294	0.110	—.184
Parker's Rock	21	0.573	0.303	—.270
Brig Rock	23	0.269	0.154	—.115

The proportion of oysters to the square yard ascertained, as described in my report of the investigation of 1878, has been calculated for each bed, and the results tabulated, together with those of the previous season, for convenience of comparison.

Though a standard has been established by the proportions

found on the unworked beds in the Bay, no comparison, except in one way, is just, the conditions of bottom and difference of growth upon the worked and unworked beds differing so materially.

The proportions on any bed, obtained by the method we have used, will always be much less than what is really the case, but they will be much less true on an unworked bed than upon one which has been for some time subjected to dredging influences, and where the bottom is soft and yielding, and the oysters grow singly or in small clusters instead of being cemented together and to the surface stratum, as they are on the undredged beds. Therefore any proportions obtained from a bed which has been worked should be larger than that obtained from an unworked one. How much so, it is impossible to say, but it is evident that a smaller proportion would indicate a failure of the mature oysters.

In calculating these proportions only first and second class oysters have been considered.

It will be seen by the table that on all the beds above Kedge's Straits there has been a marked decrease in the number of oysters to the square yard. That on the remaining beds, with the exception of Woman's Marsh and Johnson's Rocks, and considering the Thoroughfare Rocks as one, there has been an increase in the number of oysters.

That on all the beds in Pocomoke Sound there has been a marked decrease.

It will also be seen that on many of the beds the proportion falls below the standard of 0.4, that on none of them is it very much greater, and that generally speaking the proportions are less than the standard on those beds that show a gain upon the proportion established during 1878.

It would appear then, by one comparison, that most of the beds have not a sufficient number of mature oysters upon them; and by the other, that however many were taken off, yet nature could more than supply the demand.

These inconsistent results may be the result of several causes. The standard proportion may be too high, but, as has been explained, if the beds are in equally good condition,

the probability is that the dredge would bring up a larger number from the old than from the new beds.

The smallness of the proportions on the lower beds may be due to the greater depth of water and hardness of the bottom, though they do not differ greatly in that respect from the beds in the Bay, however much from those in the northern part of the Sound.

It would not be wise to decide hastily upon the evidence of the proportions, that the beds are either deteriorating or the reverse, especially as the comparison has been but of two seasons. If, after they have been continued for some time, there should be an increased proportion shown, it may be considered differently, but as all experience testifies to the deterioration of the beds, the inconsistency of the results shown by the table can probably be explained in another way than by assuming the standard proportion to be too great, and this explanation will be subsequently attempted.

INFORMATION OBTAINED FROM "SPAT COLLECTORS."

In order to ascertain when the first attachment of young took place on each bed, the comparative extent of such attachment, the influence of bottom and depth of water upon the attachment, and, finally, the increase in size of the oyster and the number surviving each period of their existence, I placed, early in July, twenty-four spat collectors on the beds in the Sounds.

It is a matter of regret that the collectors were removed by some ill disposed persons almost as soon as placed.

The last hurdle, as the bundle of tiles were called, was placed in position on July 14th, and on July 15th only four remained in position, and after the 1st of August there was but one left (No. 7, in the Big Annemessex River).

The hurdles were composed of eight or sixteen half round tiles, lashed on a wooden frame, and so arranged that the frame rested on the bottom, the tiles being thus raised about six inches above the surface.

The tiles were ordinary earthenware ones, unglazed, and were always placed so as to have their concave side underneath.

As long as the hurdles remained in position they were frequently examined in order to ascertain the advent of the young brood, and from these examinations I am of the opinion that the first attachment of oysters took place about July 17th, as on that day we discovered, with the aid of the microscope, oysters on Hurdle No. 12, on Chain Shoal, and on the 19th in the same way found them on No. 7, in the Big Annemessex.

On July 24th they were observable on the hurdles on the Great Rock, both in shoal and deep water, though the attachment probably began about the middle of July. Yet it was only evident on the tiles, as our dredging operations did not discover any attachment before the 12th of August, when the young brood were found in moderate numbers on all the beds in both the Sounds.

The number found in Pocomoke Sound was much smaller than in Tangier, and the number on the Upper Pocomoke Beds and on the Muddy Marsh Bed was smaller than on the lower ones.

The attachment appears to be proportional to the number of oysters, such beds as the Muddy Marsh, for instance, having very few young, but as the bed is badly broken up, this may be owing to the absence of proper cultch. The young appear to select the cleanest and smoothest shells for attachment, and we always found that the "boxes," or those shells which had not been separated completely, contained the largest number of young brood.

We also found that the size of the young depended, to a great extent, upon the depth of water. Those first detected by us were from two mil. to one cent. in length, and as the shoal water oysters spawn first, and as we found the young of the largest size in shoal water, I infer that the attachment of the oyster occurs very near the location of the parent.

The hurdle in the Big Annemessex was subjected to four examinations.

It was placed in position on July 9th, and on July 19th, when the first examination was made, there were a few oysters on the tiles, but so small that a microscope was necessary in order to recognize them (Record, Vol. I., Form B).

The second examination was on August 2d, and the oysters were then quite perceptible and easily counted.

The total number of oysters on the tiles was then 1,506; deducting those on tile No. 7, there were 1,177.

The number on each tile varied greatly, the maximum being 348 and the minimum 26.

The third examination was on the 23d of August. The oysters had increased very much in size and in numbers. The total number on the tiles was now 1,334, showing an increase of 0.13 per cent. of the number at the second examination. The number on the lower side of the tiles was much larger than on the upper.

A tile (No. 2) was removed, and, deducting the number of oysters on it from the sum, there were 1202 still on the hurdle.

There were a few oysters injured, probably, by raising or lowering the hurdle from and to the bottom.

The fourth examination was on the 10th of October.

The total number of oysters was then 539, showing a decrease of 55 per cent.

At this examination about two-thirds of the oysters were of the third class, or over three-quarters of an inch in length, and two of them were over two inches long, being thus of the second class. All, however, could be distinguished as of very recent growth, being very long and thin, with thin, delicate shells, easily broken with the thumb-nail or point of a penknife.

The largest numbers were still found on the lower sides of the tiles.

A moderate number of oysters had been injured by rough handling.

I infer from the four inspections made of this hurdle, and from the one or two made of others before they were removed, that the first attachment of young began, as I have said, about the middle of July, and continued until about the twentieth of August, as on the 23d of that month there was no indication of any recent attachment. Probably it reaches its

maximum number about the end of July, and decreases afterwards.

The mortality after the 23d of August was very great, fully 50 per cent. perishing from some unknown cause, which, though unknown, is certainly natural.

We did not notice any evidence of the destructive effects of drills or other animals, though as their agency would only be discovered by the evidence of the holes in the upper valves, but as those valves were never present, it cannot be said with certainty that the destruction was not due to them. Whatever the cause, the fact is that 50 per cent. perished in the first six weeks of their existence.

The tiles have shown that the increase in size is much greater than was supposed, and are the first and only authentic evidence upon that point which has been produced with regard to the American oyster.

Again, it is conclusively shown by these tiles, and some others that were dredged up from the Woman's Marsh Rocks (Hurdle No. 24), that the greatest attachment is on the lower concave side, and consequently that whatever may be the movements of the embryo oyster before attachment, during the period just prior to it, they are near, if not on the bottom, and in seeking their place of attachment they must rise. In this they are similar to the European variety.

The selection of the lower sides of the tiles and the interior of the "boxes" may be an effort of nature to provide some protection for the young brood by, to a certain extent, inducing them to seek dark and secluded points for attachment, or the large number found in such places may be due to the inability of the various enemies of the spat to get at them when thus protected.

It is a matter of very great regret that we have not a large number of specimens and observations for comparison, as all the future investigations in this field would be greatly assisted by an accurate knowledge of the rate of decrease in number and increase in size of the oysters, and it is to be hoped that the hurdle in the Big Annemessex will be allowed to remain

in position long enough to permit the meagre yet valuable information it can produce to be made public.

INVESTIGATION OF TEMPERATURES.

It was intended that a self-registering thermometer should be placed on each hurdle, and that the temperature to which the young were exposed should be noted at each examination. Fortunately, considering the fate of the hurdles, the thermometers were not received in time to be used, as was intended, and after the disappearance of the spat collectors it was not considered advisable to expose the thermometers to the same risks.

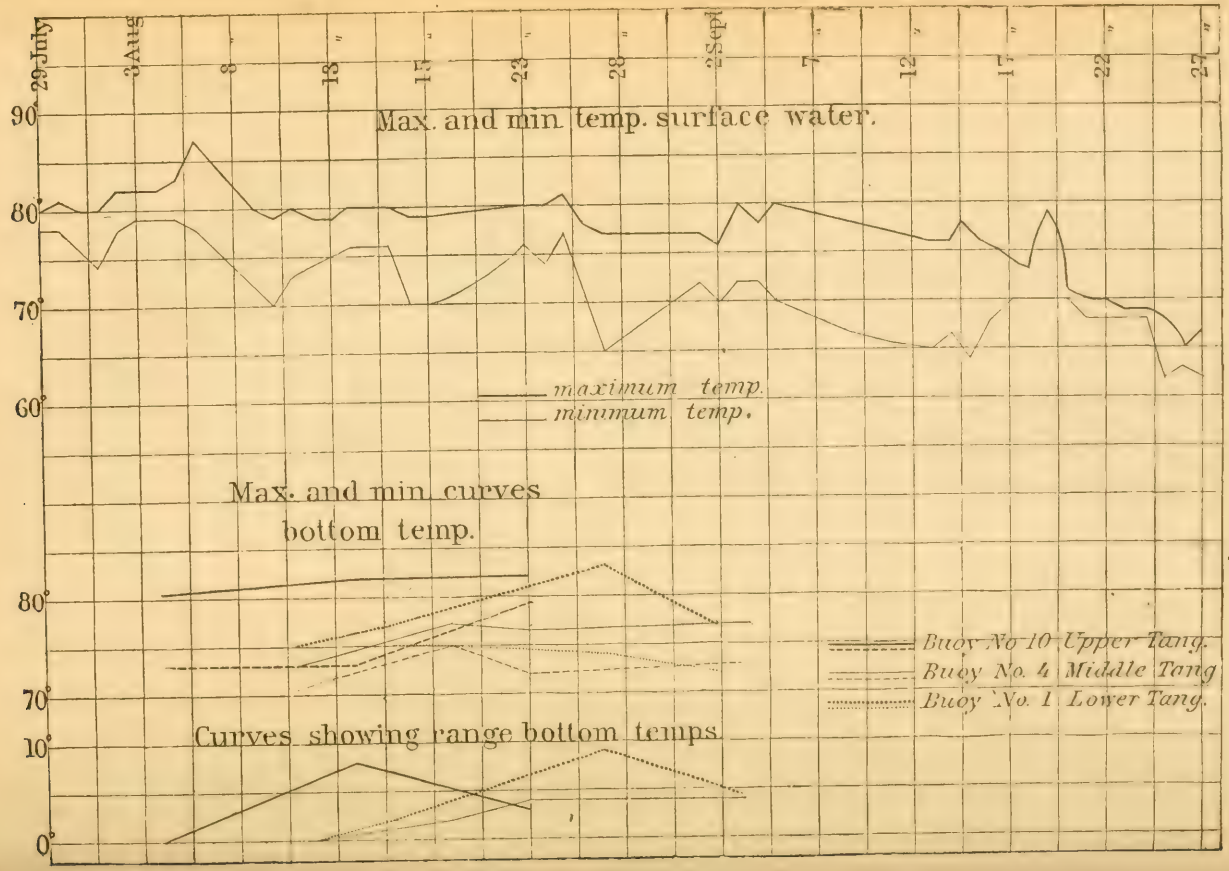
About the last of July, however, I had the temperature of the surface water recorded every two hours, and considering that there is probably but very little variation of those limits in the Sounds, I have plotted the accompanying curve of maximum and minimum temperatures from July 29th to October 1st.

It will be seen that these curves are very irregular, and that the greatest irregularities occur during the month of August, and that the greatest difference is between the 6th and 10th of August, one of 15° in four days. On the 15th there is a change of 8°, and on the 28th of 12°.

About the 4th of August I determined to utilize the channel buoys as marks for the positions of thermometers, hoping that they might thus escape the observation of those who were inclined to remove them. Accordingly I placed four self-registering thermometers on the beds—one at the foot of the buoy on the Shark's Fin, one on the buoy on Piney Island Bar, one on the buoy off Watts' Light House, and one on the buoy off Sykes Island, about the middle of Pocomoke Sound.

We were enabled to make several examinations of these thermometers, but about the 1st of September, finding that one had been stolen, I concluded to remove the others before they shared the same fate.

The curves of maximum and minimum temperature given by these thermometers, and also the range of variation, are


29 July
3 Aug
8 "
13 "
18 "
23 "
28 "
2 Sept
7 "
12 "
17 "
22 "
27 "
90°
80°
70°
60°
Max. and min. temp. surface water.
maximum temp.
minimum temp.
Max. and min. curves bottom temp.
80°
70°
10°
0°
Buoy No 10 Upper Tang.
Buoy No. 4 Middle Tang
Buoy No. 1 Lower Tang.
Curves showing range bottom temps.

shown on the same sheet with the curves of surface temperature.

The thermometers were in place too late, and for too short a period, to allow any safe conclusions to be based upon the information given by them, but it is noticeable, as an interesting coincidence, that the curves of both surface and bottom temperatures show the greatest variations about the time when the young were what is known as "spat," or during the period of, and just before, attachment, the young on the shoal beds presumably attaching by early August, and those on the deep water or southern beds somewhat later.

I regret that it was impossible for me to more thoroughly study the effects of the change of temperature, as I think the failure or success of the spatting, other things being equal, will be found to depend mainly upon the temperature to which the mature oyster and embryos are exposed during the spawning seasons.

INVESTIGATION OF THE CHANGES IN DENSITY OF THE WATER.

In order to have definite information as to the change of density of the water surrounding the oysters, and regarding such changes during the spatting season as of most importance, and as the maximum change would be most likely to occur about the time of the spring tides, I determined to obtain several specimens of water on a certain number of sections across each Sound at high and low water of the spring tides.

The sections were located as follows, and are shown on the sketches accompanying this report:

Section No. 1 was just above Hooper's Straits and at the mouths of the Nanticoke and Wicomico Rivers, in order that the influence of both the straits and rivers might be shown.

Section No. 2, for the same reason, was north of Kedge's Straits and across the mouths of the Manokin and Big Annemessex Rivers.

Section No. 3 was across the entrance of both Sounds, south of Watts' Island.

Section No. 4 was across the middle of Pocomoke Sound, that the influence of Guilford and Messongo Creeks might be known.

Section No. 5 was above the natural beds of Pocomoke Sound and across the mouth of the Pocomoke River.

Stations were selected on these sections in such a manner as to obtain specimens of the water that passed over the beds, and the specimens were taken by means of the drop water cylinders at every two fathoms of depth.

As soon as possible after securing them they were tested with the hydrometer. The results are tabulated in the "Record of Densities" and curves showing the various changes accompanying this report.

All densities are reduced to a standard temperature of 60° Fah., and 1,000 represents the density of distilled water.

In studying these curves, it must be remembered that only their variations are of particular importance. The absolute density is not so much so, except for comparison with that of other localities, but the variations in density are important, if by them we can account for the failure either of the propagation or attachment of the young oysters.

The curves will show certain irregularities due to either the variations in depth, or because the tide having changed from flood to ebb, or the reverse, on one side of the Sound at a time differing from that on the other.

As will be seen, however, the greatest variations in each month are in Tangier Sound, on the eastern side, where the influence of the rivers is felt to greatest extent.

In Pocomoke Sound the greatest variations appear to be on the western side, and I assign as a reason for this that the influence of Guilford and Messongo Creeks is of small importance compared with that of the Pocomoke River, the current from which sweeps along the northern and western parts of the Sound.

The curves show that the variation is very slight, except on the September sections.

The second series of curves, those showing the monthly changes of mean densities, indicate that the maximum change

on each section was about the 1st of September; that the variations in Pocomoke Sound were much greater than in Tangier Sound, and that the maximum changes were at the head of each Sound, and the variations diminished towards the entrances.

The third series of curves shows the same when all the observations in each Sound are assembled, but with this difference, while the density in Tangier Sound was greater on October 1st than at any other time, in Pocomoke Sound the influence of the river was still felt, and notwithstanding the diminished temperature the density on the 1st of October was less than on the 1st of August.

The fourth series of curves shows the difference in density between the upper and lower sections in Tangier and Pocomoke Sounds in each month, and indicates that the density of the water is considerably greater over the lower beds than on the upper.

The maximum density found during the summer was on section 3, in October, and was 1.0166.

The minimum density was found in section 5, in September, and was 1.0005.

By referring to the curves showing monthly changes of *mean* densities, it will be seen that in only one case, that of Section 5, does the density become less than 1.0100, and that even on this section it is evident that this was not the normal condition of the water.

There were heavy freshets in the Pocomoke River during the latter part of August and during September, which accounts for the slight density, as shown by the curves.

Mr. Barroll was informed by the inhabitants of the vicinity of the mouth of Pocomoke River that these freshets had killed large numbers of oysters, both on the natural and planted beds.

An inspection of the other curves shows that the variation of density on successive tides was not much greater on this section than on the others, and as the oysters elsewhere in the Sounds did not appear to suffer from the effects of these variations, I am of the opinion that the fluctuation was not suffi-

cient to affect the mature animal, but that in this case the water continued fresh, or practically so, for too long a period, thus killing the oysters by endosmose.

From the observations of density, then, it may be assumed that the density of the water in these localities at least cannot fall below 1.01 for any protracted period without destroying the oysters.

Whether the changes in density affect the spatting can only be ascertained by continuing the observations for a number of seasons, or by direct experiment with the spat artificially raised.

During the summer I have examined, under the microscope, 374 oysters, of which 212 were females and 162 males, or the percentage of females to males was 0.56.

The oysters were not all examined at the same time, nor were they all from the same bed, but the percentage in each of the lots examined, twelve in number, does not vary greatly from the percentage given above.

I am of the opinion, therefore, that about 60 per cent. of the oysters in a community are females. A larger number of observations is, however, desirable.

In making these examinations I have never seen both ova and spermatozoa in the same animal, though I have made many careful observations in order to detect the presence of either. I have also carefully examined the gills and mantles of a large number, and have never found an embryo oyster within the shell.

As these observations were made during the spawning season, I do not think it possible that the spat, if they are at any time contained within the gills or mantle, could have escaped my notice.

The observations as to the sex of the oyster were continued late in the season, and though the ova and spermatozoa in a number of oysters was in apparently good condition as late as the 1st of October, yet those products of generation appeared in best condition in the largest number of animals during July.

A considerable disintegration of the eggs was noticed by

the end of that month, as far as I could ascertain the condition of both ova and spermatozoa depended upon the depth of water, though the rule was not invariable.

The generative products of the deep water oysters reached a state most favorable for reproduction several weeks after the same had occurred in the shoal water; and, in general terms, neither ova nor spermatozoa in most of the oysters in either deep or shoal water after the middle of August was in a state favorable for fertilization.

Large numbers of oysters in all depths passed through the spawning season without expelling the contents of the generative organs. I found this the case especially on the beds on the western side of Tangier Sound, above Kedge's Straits, where, on the 8th and 9th of October, we found many oysters fattening with the generative matter unexpelled. I was informed that this was not unusual, and that it injured the oyster for marketable purposes.

As late as the 8th I found oysters with the generative matter in good condition, and on the 7th of October I succeeded in securing from oysters taken from Kedge's Straits a sufficient amount of ova and spermatozoa to make experiments in artificial impregnation, and was successful in producing one embryo oyster.

Probably had I used greater care a larger number would have resulted.

During the season of 1878 we observed large numbers of *astyris* in the shells of the mature oysters, and attached to those of the young. In many cases they were found in the holes which had been bored in the shells of the latter.

As we could not find any known enemy of the oyster in sufficient numbers to account for the evident damage done, and as so many circumstances pointed to the *astyris* as the cause, I concluded that the boring must be done by that animal, and alluded to it in my previous report. The specimens preserved were described by Mr. W. H. Dall, and the description appended to that report.

During the past summer we have found a much larger number of the rough welks (*urosalpinx cinereus*) than during the

previous season, and though they were not found in as large numbers as the *astyris*, yet their presence inclined me to question the conclusions arrived at during the season of 1878.

I accordingly collected a large number of the *astyris* and placed them in an aquarium jar with a number of young oysters, changing the water constantly and inspecting the animals frequently.

These observations were continued for over a week, and at the end of that time both oysters and *astyris* were alive, but there was no evidence of any boring, nor did any inspection show an inclination in that direction upon the part of the *astyris;* on the contrary, they soon left the shells and went to the bottom of the jar.

I then collected a number of *urosalpinx cinereus* and subjected them to the same test.

At the end of four days one oyster had been bored and one welk was found at work on the shell of another.

The rough welk is known to do great injury to the oyster in Long Island Sound, and the destruction of the young alluded to in my previous report, as due to the drills, may be effected by this animal.

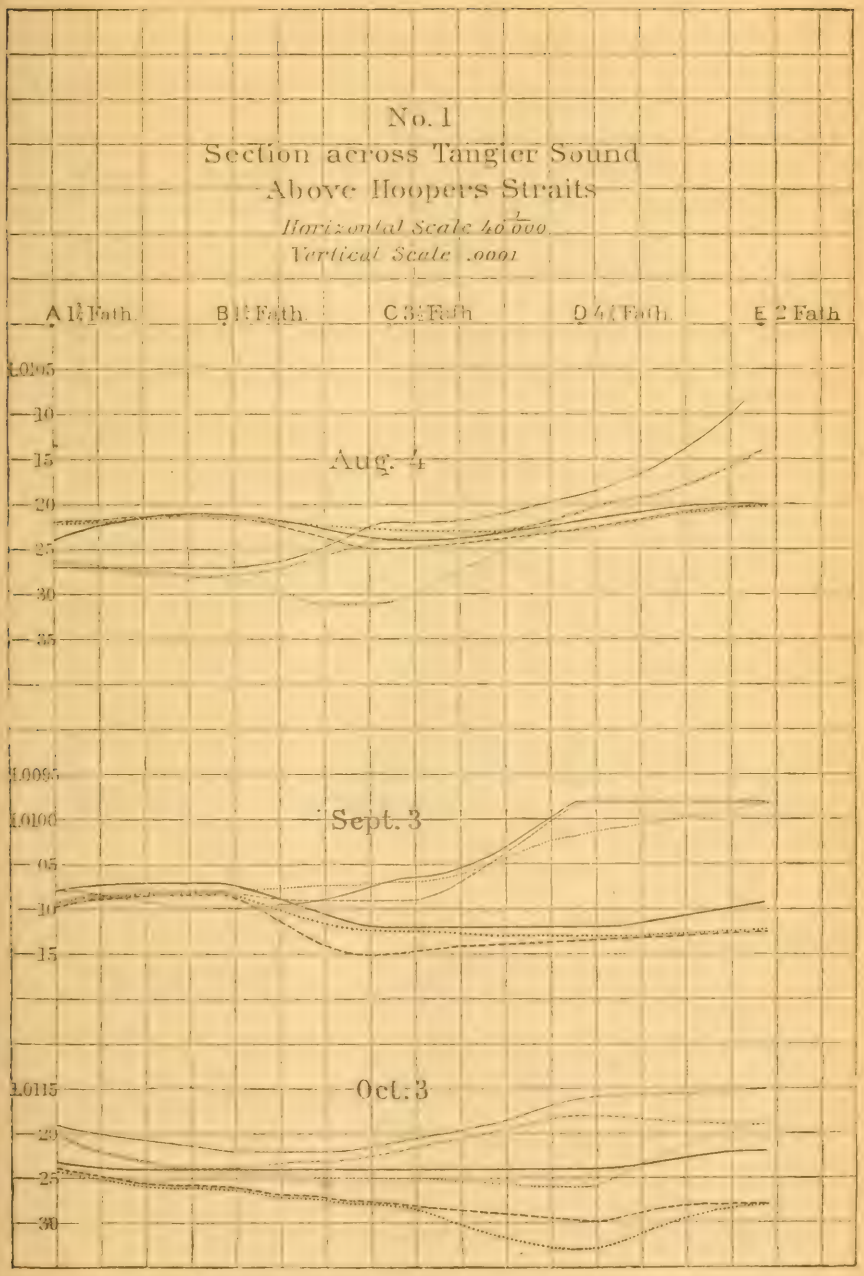
That large numbers are destroyed by the welks cannot be doubted, but it is possible that the *astyris* may also assist in this destruction.

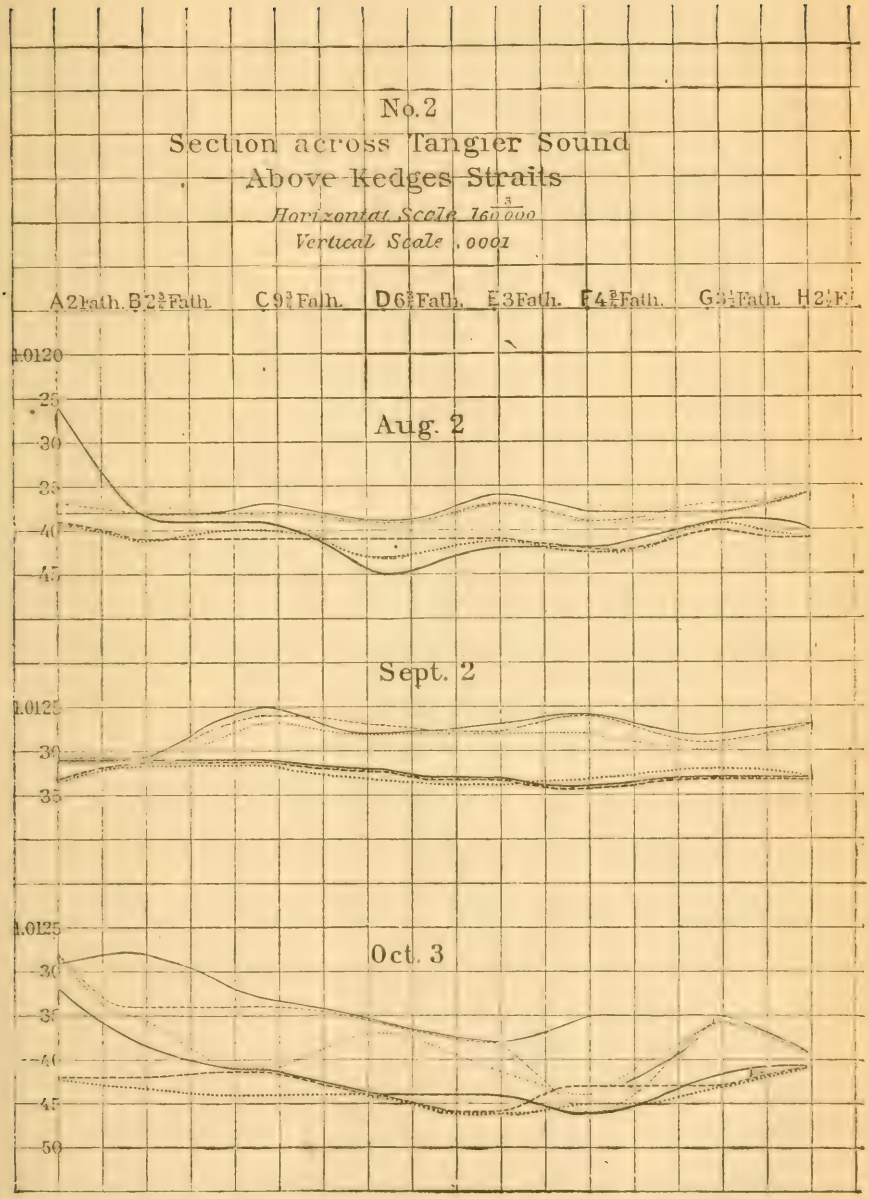
A more extended investigation of this question than I was enabled to make is desirable.

An analysis of several specimens of the water of the Sound and of the Bay, made by Prof. C. E. Monroe, of the Naval Academy, is appended to this report, for use in comparing the localities investigated with others whose investigation may be subsequently attempted.

The specimens have been selected from those taken in different stages of the tide and from different sections.

The only noticeable change on the beds this season was that the amount of red sponge appeared to be much less than in 1878. In other respects they are, to outward appearances, in a similar state, though the dredgers report them as much broken up, with an increased amount of debris.


No. 1
Section across Tangier Sound
Above Hoopers Straits
Horizontal Scale 40 000
Vertical Scale .0001
A 1½ Fath.
B 1 Fath.
C 3 Fath.
D 4 Fath.
E 2 Fath.
1.0095
10
15
20
25
30
35
Aug. 4
1.0095
1.0100
05
10
15
Sept. 3
1.0115
20
25
30
Oct. 3


No. 2
Section across Tangier Sound
Above Kedges Straits
Horizontal Scale 1/60,000
Vertical Scale .0001
A 2 Fath.
B 2½ Fath.
C 9½ Fath.
D 6½ Fath.
E 3 Fath.
F 4½ Fath.
G 3½ Fath.
H 2½ Fath.
1.0120
25
30
35
40
45
Aug. 2
Sept. 2
1.0125
30
35
Oct. 3
1.0125
30
35
40
45
50

INFORMATION OBTAINED FROM "RECORD OF STATISTICS."

The member of the party on duty at Crisfield inspected, during the season, 496 vessels directly engaged in the oyster fishery, and the results of these inspections have been recorded in the Record of Statistics, which record, to a great extent, explains itself.

Owing to the large number of vessels dredging, it was frequently impossible to visit and inspect all that entered during the day. When such was the case, those inspected were selected from different classes and from different dredging grounds that a fair idea might be obtained of the number of oysters removed each day from each bed.

The method of examination was as follows:

The total number of bushels in the load given by the master of the vessel was recorded, and with the number of hours of labor necessary to obtain that quantity, and other matters of statistical interest.

Several samples of one-quarter or one-half bushels each were then selected from different parts of the load, and the number of oysters in each sample of each class counted and recorded. The number of samples examined depended upon the number of bushels in the load and upon the character of the oysters, a large number being taken when the oysters appeared dissimilar, and when the quantity was great. At least three samples were usually examined.

In most cases the average number of each class per sample was nearly the same as that given by each term, and, consequently, it is assumed that a close estimate of the number of each class in the entire load was obtained by multiplying the number of each class in a bushel, as shown by the samples, by the total number of bushels in the load.

From the record of these inspections I have been able to determine with practical accuracy the number of oysters of the several classes removed from the various beds by each description of dredging vessel.

After September 1st, when the dredging began, we counted each day all the vessels in sight from the "Palinurus," specifying the size and the ground upon which they were working,

and the masters of the dredging vessels were also requested to note the number of dredgers working in their vicinity, which they in many cases very obligingly did.

As even with this *data*, the number of working days given on each bed is very small, and because no bed is dredged continuously during the season, but at intervals, I have divided the sections in a similar manner to that described in my previous report.

The first section includes the beds north of Piney Island Bar and the Muscle Hole.

The second section, those from the Muscle Hole and Piney Island Bar to the Great Rock.

The third section the remaining beds in Tangier Sound, and the fourth section all the Pocomoke Beds.

By this arrangement duplication of the vessels counted is prevented, and the average number of vessels working each day is more nearly a correct estimate.

The vessels dredging on these several sections, as counted by ourselves and by their masters, have been assembled: the number of oysters assigned to each class of vessel working in the section has then been multiplied by the number of vessels of each class, and the total number of oysters taken off the beds in each section thus obtained.

The number of oysters taken by any vessel in a day varies greatly, owing to the weather principally, but in assigning the quantity on each day, the number brought in by vessels of the same class, as shown by "Record of Statistics," has been used, as a more correct estimate is thus assured than would be given by using the average for the whole season.

The following table has been compiled from the calculations, and shows the number of oysters taken from each section in a specified number of days, and supposing the observations to have extended over a sufficient period, the number of oysters has been divided by the number of days, and the average number removed in each day thus obtained:

TABLE SHOWING ESTIMATED NUMBER OF OYSTERS REMOVED IN 1879.

Section 1, Upper Tangier Sound.

	No. Sail.	1st Class.	2d Class.	3d Class.	4th Class.	1st and 2d Class per sail.
Total No. of oysters removed in 12 days	By 521 sail	2,322,200	1,934,200	1,382,500	371,000	8100
Average per day		192,683	161,183	115,200	30,916	
Total 1st and 2d per day		353	866			

Section 2, Middle Tangier Sound.

	No. Sail.	1st Class.	2d Class.	3d Class.	4th Class.	1st and 2d Class per sail.
Total No. of oysters removed in 17 days	By 634 sail	2,463,800	1,623,860	1,132,060	384,220	6400
Average per day		144,929	95,521	66,591	22,600	
Total 1st and 2d per day		240	450			

TABLE SHOWING ESTIMATED NUMBER OF OYSTERS REMOVED IN 1879—Continued.

SECTION 3, LOWER TANGIER SOUND.

	No. Sail.	1st Class.	2d Class.	3d Class.	4th Class.	1st and 2d Class per sail.
Total No. of oysters removed in 34 days	By 951 sail	2,329,600	1,413,610	1,407,230	558 900	3900
Average per day		68,223	41,576	41,389	16,438	
Total 1st and 2d per day		109	799			

SECTION 4, POCOMOKE SOUND.

	No. Sail.	1st Class.	2d Class.	3d Class.	4th Class	1st and 2d Class per sail.
Total No. of oysters removed in 9 days	By 169 sail	256,809	121,103	88,800	20,108	2200
Average per day		28,534	13,567	9,866	2,234	
Total 1st and 2d per day		42	101			

Total No. of oysters removed in one day 746,226

It will be noticed that the number of dredging vessels increases on each succeeding section in Tangier Sound, but that the number taken by each sail, and the yield per day, decreases. Also that the number of sail in Pocomoke Sound is much smaller than in any other section, and that the yield per day is also much smaller.

The character of the bottom and the depth of the water materially influences the yield of the bed, those in shoal water with soft bottoms allowing more frequent hauls of the dredges than those in deep water or on hard bottoms. But as the dredges used in deep water and on hard bottoms are usually much heavier, this inequality is overcome to some extent.

Again, the large vessels take a greater proportion of the oysters than the small ones, and those large vessels usually work on the deep water beds.

Considering the different sizes of the vessels and the superiority of the crews of the larger ones, and the heavier dredges used by them, I am of the opinion that the disparity between the yields of the Upper and Lower Tangier beds is greater than it should be.

The beds of the Middle Section are, with the exception of Piney Island Bar, similar to those of the upper section; yet, with a larger number of vessels working, the yield of that section is less than the upper.

These facts, I think, show that the beds in Lower Tangier Sound are less productive than those in the upper.

The dredging in Pocomoke Sound was principally on the upper beds, and none was done as far as we could ascertain on either the Brig or Parker's Rocks.

As the middle and upper beds in this Sound are very similar in character of bottom and depth of water to the middle and upper beds in Tangier Sound, it would be inferred that the yield per day in Pocomoke would be about the same. On the contrary, as shown by the table, it is absurdly small; and, considering its size, it is not astonishing that the beds have been to a great extent abandoned.

Taking the number of oysters removed each day, and considering, for the reasons give in my previous report (Vol. 2—con-

clusions), the working season to be of 120 days, I have compiled the following table, in which are given the number of oysters removed from each section and from the Sounds in one day and in the season. I have also given the same estimated in 1878 for comparison.

TABLE *showing the number of Oysters Removed.*

Section.	In One Day.		In One Season.		1879. Number of Young Growth.	
	1878.	1879.	1878.	1879.	Per Day.	In the Season.
No. 1.....	567,450	353,876	68,094,000	42,465,120	146,100	17,532,000
" 2.....	378,450	240,450	45,414,000	28,854,000	89,200	10,704,000
" 3.....	459,000	109,799	55,080,000	13,175,880	57,800	6,936,000
" 4.....	133,650	42,101	16,038,000	5,052,120	12,100	1,452,000
All Sections..	1,538,550	746,226	184,626,000	89,547,120	325,200	36,624,000

The estimated number of young removed from all sections in one day, in 1878, was about 1,240,000, or 148,800,000 in the course of the season.

It will be seen by the table that about one hundred million more oysters were removed in 1878 than would be in 1879, and that about the same excess exists with regard to the young.

Of the two estimates, that of 1879 is much more accurate, being based upon a larger number of observations, more carefully and systematically taken, than was possible in 1878, but the disparity between the two is so great that the estimate of 1878 would appear valueless, could not some cause be assigned for a decrease in the number of oysters taken from the beds.

This decrease, as may be easily seen, must be due to one of the following causes or to both.

1st. The fertility of the beds remaining the same, the dredgers may not be as numerous.

2d. The number of dredgers remaining the same, the beds may be exhausted; or, becoming so, consequently there would be a smaller number of oysters produced.

3d. The number of dredgers may have decreased and the fertility of the beds may be greatly impaired.

There are no statistics of the oyster fishery in the localities under consideration except those collected by myself, and I am consequently obliged to put a greater dependence upon them than they intrinsically merit. They are necessarily somewhat rude, but in the absence of other information they can be used as giving some indication of the probable progress of the fishery in the two seasons under consideration.

By examining my previous report (Appendix C) it will be seen that in thirteen days we counted 1595 vessels working on the various beds in both Sounds.

From our records of the past season I find that the number observed by all persons was, in thirty seven days, 2275, or in 1878, the average number working on each day was 122, while in 1879 it was 61, or about one-half as many.

Therefore, the small yield of the beds during the autumn months of 1879, and the small estimate of the yield for the year, may be accounted for by the smaller number of vessels at work.

As in round numbers the number of oysters estimated as taken in 1879 was about one-half that estimated in 1878, I think that the previous estimate may be accepted as practically correct.

My last advices from Crisfield inform me that there is but very little dredging going on in the Sounds, most of the vessels working in the Bay and in the Potomac River. The principal cause assigned for this is, the presence of young growth on the beds, by which is meant immature oysters under two years of age.

The presence of this class in large numbers prevents the oysters from fattening rapidly.

Another reason given is that the beds are much broken up, and that the returns are very poor for the usual amount of labor.

CONCLUSIONS.

My additional experience in the investigation and information collected during the past season has proved that a few

of the conclusions at which I arrived in 1878, and which are contained in my report of the operations of that season, are erroneous. Some of them have been already alluded to, and the allusions to the remaining ones here find their most appropriate place.

I find that my supposition that there is or was a general spatting on all the beds in any season to be, to a certain extent, incorrect. The spatting may be general, and a majority of the oysters may spawn each year, but the attachment of the young is a very different thing, and as the most precarious period in the life of the oyster is that just anterior to its attachment, a series of causes detrimental to the life of the embryo, while it is in its free swimming state may readily occur, and thus prevent such attachment.

My investigation of the past season has proved conclusively that the class of oysters termed "young growth" in my previous report were not of the brood of 1878 but of 1877 or 1876. The character of the young found in both seasons, the determination of the time of earliest attachment, and the growth and appearance of the oysters on the tiles, have led me to this conclusion. As the young do not attach before the middle of August, they could hardly reach such a size and shape by October as would prevent their recognition as of the same season's growth.

From the inspection of the oysters taken during the last season, many being found as I have stated with the generative matter unexpelled, I am of the opinion that a combination of natural causes may prevent the expulsion of both the male and female cells, and there would consequently be no impregnation during that season.

As I mention in report of 1878, many persons of experience are of that opinion, and I now concur with them in thinking that not only the attachment of young may not be general nor occur each year, but that the emission of the products of generation may also be frequently confined to partial areas, and that by a combination of circumstances there can be a total failure of impregnation on all beds of any locality.

I also find by additional experience that the young oyster is

not fit for marketable purposes until at least a year and a half or two years old, and consequently the total number of young removed, as estimated in my previous report, would be a total sacrifice.

As will be seen by the table showing the number of oysters removed, this sacrifice probably amounted in 1878 to 148,800,000 oysters.

By reference to the tables showing the success or failure of the several spatting seasons, it will be seen that there is little or no regularity of either success or failure.

We have only been able to investigate the spatting of three seasons, and it may be found by subsequent observations that two similar seasons of success, moderate success or failure will follow each other, but so far this has not been the case, and in the period of three years we have, comparatively to the other seasons, one at least of successful attachment.

I can see no reason for supposing that there is any regular recurrence of the spatting seasons, but am inclined to believe that the success or failure is due to two causes; variations of temperature and variations of density.

I have no means of ascertaining either the changes of temperature or density in the years preceding those in which I have been engaged upon this investigation, and in both seasons I arrived in the Sounds too late for the temperatures or determinations of density obtained by the party to be of practical value.

Oysters will and do live in very dissimilar temperatures, and in waters of very different densities, as is shown by their existence in the waters of North America from Nova Scotia to the Gulf, and on both Atlantic and Pacific Coasts. That the mature oyster is a hardy animal, readily adapting itself to new conditions and environment, is shown by the ease with which it is transplanted from the warm waters of the Chesapeake to the colder ones of New England; from the dense and salt waters of the ocean and Bay, to the brackish waters of the creeks and rivers or vice-versa, and from soft bottoms to hard or the reverse, but naturally this hardiness is not a quality of the immature oysters or the swimming embryos.

The influence of increased or diminished temperature upon the formation of the ova and spermatozoa must be very serious and very considerable, and, judging by analogy, it would seem probable that the formation would be more rapid during a warm spring than during a cold one.

Whether the formation has been late or early when once formed, a sudden change of density or of temperature may so affect the oyster or the generative matter that the latter would not be expelled, and only upon this hypothesis can be explained the retention of the products of generation noticed in so many oysters, and which is said to be so common, for none of the other conditions are subject to violent changes, such being peculiar to the density and temperature alone.

Prof. Brooks states that he found both ova and spermatozoa ripe and fit for fertilization about the middle of May, and as the oysters were taken from shoal water, probably one fathom deep, the shoal water oysters were probably spawning throughout June. Both Prof. Brooks and myself found the ripeness of the oysters to depend upon the depth of water from which it was taken, and this is no doubt caused by the difference of temperatures.

Prof. Brooks also states that there was a great deal of cold, rainy weather during June, and two hail storms. The rainy weather would affect the density of the water by increasing the volumes of the various creeks and rivers, and the changes of density would probably affect the production and emission of the generative matter.

It is an interesting coincidence at least, that the oysters found to be fattening with the products of generation unexpelled were either from beds in comparatively shoal water or from the shoal parts of deep water beds, and that those oysters should have been ripe and spawning during the month of June. Again, it may be that the lowness of the temperature prevented the deep water oysters from ripening as soon as usual, and the mildness of the succeeding autumn may have prevented the destruction of the ova and spermatozoa, thus rendering possible the fertilization achieved by me in October. The oysters from which I procured the ova and spermatozoa were taken from deep water.

Probably the influence of changes of environment, especially of density and temperature of the water, is most severely felt by the embryos when in their free swimming state, and, in connection with the want of success of the spatting seasons in the Sounds, it is noticed that the temperature curves show a maximum change about the time when it is supposed that the young would attach in largest numbers, or about the period when they were swimming about in the water.

It is also worthy of notice that Prof. Brooks, about this time, met with the maximum amount of success in his efforts to artificially raise the embryos.

In consideration of the foregoing, I am of the opinion that the success or failure of any spatting season is dependent upon the equability of the temperature, and that the higher the temperature during the spring months the earlier the advent of the spawning season, and that an increased temperature will also hasten the development of the spat, and of the young oysters after they have become attached.

I also infer that sudden and extensive changes of density will likewise affect the advent, duration and success of the spawning, though to a less extent.

Subsequent to the attachment of the animal, changes of the conditions surrounding it are not of so much importance, though naturally such changes will more severely affect the delicate organism of the young oyster than that of the older and more hardened adult.

During the first six months of its existence the oyster is exposed to the greatest danger from the numerous enemies which surround it. The thin, delicate shells, from one-sixteenth of an inch to one inch in diameter, are readily bored by the drills or torn off by the crabs, and the immense numbers of both of these leave no room to doubt their destructive effects. The inspection of the spat collectors in the Big Annemessex River shows that during the early months of their existence about 50 per cent. of the young oysters are destroyed, and future inspections of the hurdle will, I hope, give the rate of decrease in other periods of time.

Naturally, as the animal progresses, it becomes more hardy

and better able to resist the attacks of enemies and changes of environment, and thus we find on the unworked beds, where the oysters are practically in a natural state, that the decrease in passing from young growth to mature oysters is about 30 per cent., or about one-third of a given number perish in passing from the first to the fourth year of their existence.

Here our information ceases, but enough has been gathered to indicate the proportion which nature has assigned as necessary between the young and the mature oysters. For every 1000 of the latter there should be 1500 of the former, if the number of brood oysters necessary to maintain the fecundity of the beds is to be kept up, and though this proportion is based upon *data* which is not quite sufficient, yet, as I have said, it is all that has been afforded as yet, and may be accepted within certain limits. Certainly whatever it should be, the number of the rising generation of the animals should never be less than that of the older, or there should always be as many young as mature on any bed.

A greatly increased proportion of young to mature oysters would show either one of the two things—either the mortality in passing from youth to maturity was much greater than shown by the dredging results in the Bay, or that a very large number of mature oysters had been removed by other than natural causes.

In considering these several beds the question of food and other necessary supplies has not been considered, as it is evident that when an oyster bed is formed and exists naturally, all the conditions for its successful life are probably present, and any failure of an important supply would be followed by a speedy extinction of all the oysters on the bed. Such determinations of the quality and quantity of the food, character of bottom and water, and other matters, are only of interest and desirable for the purpose of comparing one locality with another. Such was not the purpose of this investigation, and consequently the determination of those points has been but incidental to the work.

Probably the fecundity of a bed is increased to a certain

extent by working upon it. The dredges or other implements used open the bed and spread it, thus giving more room for development, and allowing a greater amount of food to reach the animals.

The mortality is great in all thickly populated tracts and in any closely united community, and it is evident that the removal of any of the brood oysters could not be effected without destroying the fecundity of the bed, did not this very removal influence the mortality among the young so as to allow a larger number to come to maturity. But this removal of brood oysters may become so great that the most violent exertions of nature to supply others are unequal to the demand.

It must also be evident that as soon as the number of brood oysters is thus diminished, even to the slightest extent, the fecundity of the bed is impaired.

This impairment constantly increases, influencing, as it does, both old and young. As the number of the latter decrease, so will the number of the former, and as that number is again and again diminished, the number of young produced by them must constantly diminish. Thus the cause for the destruction of the fecundity of the bed, and the gradual extinction of the animals upon it, can be readily understood and as easily comprehended as the fact that the fecundity and preservation of the productive powers of a bed depends upon the number of mature, spawn-bearing oysters upon it.

It is not meant by this that none but the mature oysters are capable of reproduction, as such is not the case, oysters of even six or nine months' growth having been observed by me with ripe ova and spermatozoa in them, but the main dependence must be placed upon the adults in the community, as the spawn of the young growth is not considerable when compared with that of the other class.

Without a knowledge of the number of oysters on a bed it is impossible to say what number should be removed, and as an attainment of the knowledge of the number on the bed is almost impossible, all that can be done is to keep the proportions between the young and the mature as nearly the

same as on the natural beds, and this should be the aim and result of all laws having the protection of the beds in view.

Whether such a law is necessary or not for the locality subjected to the examinations of the last two summers I will not attempt to show.

Referring to that portion of this report relating to the fecundity of the beds in the Sounds, it is seen that in some cases the ratio of young to mature oysters is greater, and, in other cases, less than it should be, and that in a few cases the proportion seems to be within the prescribed limits. As has been shown, the decreased ratios must be the result of a want of reproduction, while the increase may be due to the removal of the mature oysters.

If we take the total number of the oysters examined in the Sounds we will have a ratio expressing the general fecundity of the beds, and this ratio between 70,866 mature oysters and 36,824 young ones is 0.5.

Assembling all the oysters counted on the beds in the Bay we would have as a ratio 1.5.

Practically, none of the mature oysters had been removed from these beds in the Bay, while large numbers had been taken from those in the Sounds. The estimates of each show approximately how many have been taken, and if by examination of them we find that the number of mature oysters taken off greatly exceeds the number of young removed, it may be assumed that the restoration of both classes to the beds would be immediately shown by a change in the proportion of young growth to mature oysters.

By the estimate of 1878 we find that 184,600,000 mature and 148,800,000 young would be removed.

But as the number of young removed would be less and less during the season, on account of the mortality among them, and as we have found that mortality to be about 50 per cent., I consider that the removal of the young during the season of 1878 and 79 probably did not exceed 74,400,000.

Therefore the total number removed was 259,000,00, of which 71 per cent. were mature, spawn-bearing oysters.

But 65 per cent. of the oysters at present on the beds are

mature, and the addition of the 260,000,000 removed would raise this percentage to 68, which would make the ratio even smaller.

Hence, the addition of a large number of mature oysters to the total number considered in both Sounds would prove even more conclusively that the fecundity was greatly impaired.

The two beds of which we have the most exact and complete statistical records in this season are the Woman's Marsh and the Great Rock, and, by means of the record of statistics, I estimate that the following number of oysters have been removed from them:

TABLE *showing number Oysters Removed from Great Rock and Woman's Marsh.*

Name of Bed.	Removed in a Year.		Total both classes.	Percentage of Mature.
	Mature.	Young.		
Great Rock	10,176,000	5,640,000	15,816,000	64
Woman's Marsh	1,740,000	768,000	2,508,000	69

From Table II, Dredging Results in the Sounds, I find the percentage of mature oysters to the total number on the two beds mentioned is on the Great Rock 24 and on the Woman's Marsh 36. Hence we would have on the Great Rock 44 per cent. of the oysters mature and full grown, and on the Woman's Marsh 52 per cent. mature.

We find by making a similar calculation for Piney Island Bar that the percentage of mature oysters removed is 70, and that by the dredging results 20 per cent. were mature; hence, 45 per cent. represents the percentage on Piney Island Bar.

The ratios on these beds would then, were the oysters removed still present, be 1.2 on the Great Rock, 0.9 on the Woman's Marsh, and 1.2 on Piney Island Bar.

It will be seen by the above that there has been an exhaus-

tive fishing of many of the beds in the Sounds during the last four or five years—that is, exhaustive of mature brood oysters—and that consequently the large ratios of young to mature oysters is not the result of a large attachment of young, but rather of the removal of the older oysters, and, hence, the change from a large ratio to a very small one, or vice versa, may be regarded as a safe indication of the deterioration of the bed, for, as explained in the previous part of this report, the ratio will remain abnormally large until the young growth reach maturity, when it will become abnormally small, and will so remain for a few years, when it will again become very large, and this process will continue for some time, until the beds are practically unfit for dredging, as is the case in Pocomoke Sound.

Thus we see that not even the ratios alone are sure indications of the increase or decrease in the number of oysters, but that they must be considered together with other facts before we can arrive at just conclusions.

By reference to the closing paragraphs of that part of the report relating to the fecundity of the beds, it is noticed that the amount of *debris* increases on the southern Tangier beds, and that on most of the beds of the Sounds it is much greater than it was in the Bay.

An increase of this percentage, as already pointed out, is an indication of the deterioration of the beds, and is due to the destructive effects of the dredging, which not only removes many oysters, but so disturbs many others that their destruction is an almost assured fact.

To a certain extent this cannot be helped, and is a necessary incident of the fishery, but overworking the beds increases this evil as well as others, as is evident by the percentage on many of the Pocomoke beds.

Referring to the table showing the number of oysters removed in 1878, and also comparing it with the table of proportions to the square yard, the following may be noticed:

1st. In the upper part of Tangier Sound the proportions to the square yard are very large, which is probably due to the shoalness of the water and the soft bottom, which allowed

a larger number of oysters to be taken. In addition, the mature oysters are smaller than on the southern beds, as shown in the Table I, Dredging Results, thus a greater number would be taken in the dredge and the proportion increased.

2d. Though the proportions are very large, yet there is a serious decrease from that established in 1878.

By reference to the "Table showing number of oysters removed," I find that the largest number of oysters were removed from this section in both seasons, and supposing the number of dredging vessels to have been constant, instead of diminishing, one-half the number of oysters removed in 1879 would be greater by fourteen millions than the number removed in 1878, or that the fishing is proportionally increasing.

As this fishing is confined principally to the mature oysters, it can be readily understood why the proportion of these oysters to the square yard should be much decreased.

In the second section we find the proportions to be nearly the same as those outside, and that there is a gain in the rivers where there is the minimum amount of dredging, and on two beds which were worked very little in 1878–9, on account of the young growth which had attached to them.

The proportional increase of dredging, as shown by the numbers removed in each season, supposing the number of dredging vessels to have been the same, would be on this section eleven millions, and these were taken from the western beds and Piney Island Bar principally, and on these beds there is a diminished proportion.

Again, we find by reference to the tables that on the southern beds in Tangier Sound the proportion to the square yard is much smaller than that on the beds in the Bay, and this is due to probably two causes—the condition of the bed or the depth of the water, hardness of bottom and size of the oysters, and to the removal of too large a number of mature oysters.

As I have pointed out a proportion on a worked bed which falls much below that on an unworked one, must, other things being equal, be accepted as an indication of a decrease in the

productivity of the bed. That much is assumed, but on this section there appears to be an increase in the number of oysters, and that increase must be accounted for in some way.

The table showing the number of oysters removed proves that the number taken from this section to be a constantly decreasing one, for in 1878 there were taken by twice as many vessels four times as many oysters as were removed in 1879.

This may be due to two causes, and probably is due, to some extent, to both. The productivity of the beds may be impaired, or the fishery may be less earnest and exhaustive than in the past. We can only account for the increased proportions by assuming the latter to be the case, the beds having probably enforced a resting period by the material failure of the oysters.

The proportions and yield in Pocomoke Sound need no comment. Not only are the proportions below the standard and decreasing, but the yield is also decreasing, as it naturally would under such circumstances.

Naturally, as soon as any bed ceases to give an adequate return for the labor expended upon it, the dredging vessels will seek other and more profitable fields for exertion, and the desertion of any bed may be accepted as an indication of its decreased productive power, and, as has been mentioned under the head of Statistical Information, dredging vessels have, to a great extent, left the Sounds for the waters of the Bay and Potomac River.

Considering the abnormal ratios between the mature and young oysters; the increased percentage of *debris* on the beds; the smallness of the proportions to the square yard, and the decrease of those proportions on most of the beds, together with the large number of oysters, young and old, annually removed, I am of the opinion that though the fecundity of the beds in Tangier Sound is not yet destroyed, it is very much impaired, and that not only are the beds rapidly and surely deteriorating from the excessive fishery, but that their total failure, like unto that in Pocomoke Sound, is but a question of time.

So far as it is possible to make any more exact prediction

than the above, I am of the opinion that the fishery still continuing this failure will occur soonest on the beds at the entrances of the Sound on those in Sections 1 and 3, and of the two the failure of the lower beds is most likely to first occur, and of all the beds, the Woman's Marsh will be the first to give out.

As stated at the beginning of this report, the beds may be protected either directly or indirectly by either enlarging the areas for the dredgers, ensuring by artificial means the maturity of a larger proportion of the spat, or directly by limiting and restricting the fishery.

I alluded in my previous report to the manner in which this protection was afforded abroad, and suggested a manner for affording it at home, and the necessity for the adoption of some such measures seems so urgent that I earnestly hope they will shortly be undertaken.

The extension of the dredging ground can be easily attained by depositing the shells from the shell heaps about the packing houses on the bottoms contiguous to the natural beds, but such deposit should always be made in the direction of the ebb and flow of the tide, in order that the drifting spat may be carried over the newly exposed cultch. The bottom is of minor importance so long as it is of sufficient consistency to prevent the oysters from sinking into the mud. A sticky clay bottom is preferable, though the beds may be extended over sand shoals.

In searching for new beds they will probably be found about the mouths of estuaries and rivers and where there are sudden changes of bottom in the Chesapeake, depths of from two to four fathoms will be most likely to reward a search, and, where there are large beds in the creeks and rivers, it is likely that there has been a natural expansion through their mouths, and beds will probably be found off of them.

The search must be carefully conducted, or the beds which appear to be long, narrow ridges, will be missed, and the dredge should be dragged across the tide, as the beds usually extend in the direction of the current. A sudden change of depth of two or three feet, and from soft to hard bottom when on

an oyster ground, is an unfailing sign of the presence of a patch or bed.

Considering the success which has attended the investigation of Prof. Brooks, and the new light which it has thrown upon the embryological life of the oyster, I think that perhaps the most efficacious means of maintaining the productive power of the beds would be in bringing, if such be possible, the artificial impregnation of the eggs and subsequent care of the young to such a state of perfection as would be of practical utility.

Prof. Brooks is, of course, the best person to devise the method of successfully continuing his experiment, and I hope that he may be able to do so, and that they will meet with complete success, and, as pertinent to his work, which is mainly conducted by means of aquaria, I would suggest that the study of the effect of changes of temperature, so far as they affect the embryo, can be best and most easily done while engaged upon the attempt to artificially raise them. In order to arrive at certain conclusions, with regard to the effect of changes of density or of temperature, the investigation, if conducted on the natural beds, must be extended over many seasons in order to insure by a coincidence of temperatures or densities and results the elimination of other affecting conditions.

The study of the temperature seems so important that any suggestion with regard to it is of value and should claim attention.

I would also recommend that some person inspect and count at intervals the oysters on the spat collector in the Big Annemessex River. It is securely moored and buoyed with a spar buoy, and probably will remain in place.

With regard to the protection of the beds in the Sounds, I can only renew my previous recommendations of the previous year.

The deterioration of any bed will be evident by abnormal rates of young growth to mature oysters, by a small and decreasing proportion to the square yard, by large and increasing percentage of broken shells and other *debris*, and by the appearance of the oysters, as has been described.

When all these indications are present, if the dredging is not totally prohibited, it should at least be so limited as to insure the proportion of young growth remaining at least one-third greater, and great changes from this proportion are to be avoided and guarded against.

OYSTER LAWS.

OYSTERS.

PUBLIC GENERAL LAWS.

Chapter 364 *of Laws of* 1870 *as amended by Chapter* 157 *Laws of* 1872, *which repealed Chapter* 406 *Laws of* 1868 *and Chapter* 184 *Laws of* 1867, *which repealed Article* 71 *Code of Public General Laws as amended by Chapter* 333 *Laws of* 1864, *and Chapter* 181 *of the Laws of* 1865 *are repealed by Chapter* 181 *Laws of* 1874. *Sections* 3 *and* 5 *of Chapter* 181, *Laws of* 1874, *are repealed and re-enacted by Chapter* 380 *Laws of* 1876.

Laws of 1874, *Chapter* 181.

SECTION 1. *Be it enacted*, That no steamer shall be used in catching oysters in this State, and no other boat shall be used in catching oysters with scoop, dredge or similar instrument, without first having been licensed as hereinafter provided. Prohibited

SEC. 2. *Be it enacted*, That the Comptroller of the Treasury shall, upon application of any person who has been a resident of this State for twelve consecutive months next preceding such application, and to no other person, issue a license to such resident to employ such boat in catching oysters with scoop, dredge or similiar instrument, within the waters of the Chesapeake Bay, and in Eastern Bay, outside of a line drawn from the southwest corner of second Kent Point to Wade's Point; provided, that nothing herein contained shall authorize the catching of oysters with scoop, dredge or similiar instrument, on any oyster bar within one and a half miles of Talley's Point, Sandy Point, Hackett's Point, Thomas' Point, Holland Island Bar, Three Sisters, Swan Point Bar, Poplar Island, one-quarter of a mile west of, and between the island and the main land, nor within half mile of Plum Point, and to buy and sell oysters in Issue license to catch oysters.

Time in force.

this State; which license shall hold good for one year, but shall only authorize the catching of oysters between the first of October and the first of May; but it shall be lawful for the owner of any such boat licensed, whenever said owner shall sell and convey by bill of sale, for a *bona-fide* consideration, said boat unto any person who has been a resident of the State of Maryland for at least one year, to tranfer the said license to said vendee with said boat; which license, when transferred, shall entitle said vendee with said boat to the same privileges for catching oysters in the waters of this State that the original vendor or assignor had before said assignment; provided the said vendee and assignee shall appear before the Comptroller of the Treasury and make oath before him to all the facts, matters, things and prerequisites required of said original vendor or assignor before taking out such license, upon which said license said Comptroller shall certify the fact of said vendee or assignee having taken said oath, and for which said assignee or vendee shall pay the sum of five dollars, to be paid to the State of Maryland.

Transfer.

Laws of 1876, *Chapter* 380.

Make oath.

Sec. 3. *And be it enacted*, That the owner of such boat shall make oath before the Comptroller or his clerk, or before the Clerk of the Circuit Court of the county in which he shall reside, or if he resides in the City of Baltimore, before the Clerk of the Court of Common Pleas in said city, that he is the *bona fide* owner of such boat to be described in the license; that he has been a resident of the State for the time beforementioned; that there is no lien on said boat held by a non-resident; that the said boat is not held with an intention to violate the provions of this article, such applicant shall produce before the Comptroller or the said clerk at the time of such application Custom-House enrollment or license of such boat, and if such boat is under Custom-House tonnage, the owner shall swear as to her tonnage, the master of such boat shall make oath before the Comptroller or clerk aforesaid, that he has been a resident of the State of Maryland for twelve months next preceding the time of taking such oath, and in all cases where such oath shall be

Make oath.

administered by the Clerk of the Circuit Court, or the Clerk of the Court of Common Pleas as aforesaid, such clerk so administering such oath shall certify the same fully in accordance with the provisions of this article, under seal to the Comptroller, and shall deliver such certificate to the owner or master so applying, for which certificate the said clerk shall be entitled to receive a fee of fifty cents in each case. Fee.

Laws of 1874, *Chapter* 181.

Sec. 4. *And be it enacted*, That before granting such license, the Comptroller shall receive for it, from the applicant, at the rate of three dollars per ton for every ton the boat may measure; the license shall be exhibited whenever called for by any officer of the State of Maryland. Charges.

Laws of 1876, *Chapter* 380.

Sec. 5. *And be it enacted*, That any person who shall violate any of the provisions of the preceding sections shall be deemed guilty of a misdemeanor, and on conviction thereof, in any court in this State having criminal jurisdiction, shall be sentenced to the jail of the county where the case is tried for a term not exceeding six months, or a fine not exceeding two hundred dollars, or both in the discretion of the court; provided, however, that nothing in this or the preceding sections shall be construed to apply to the sailors or crew on a vessel licensed as aforesaid; provided further, that if the captain or commander of the boat shall not be on board at the time of violating the law, the person having charge of the boat shall be held to answer the charge; and provided further, that nothing in this section shall be construed to apply to cases now pending for the violation of the Oyster Laws. Guilty of a misdemeanor. Proviso. Proviso.

Laws of 1874, *Chapter* 181.

Sec. 6. *And be it enacted*, That upon information given on oath to any judge or justice of the peace of any violation of any of the provisions of this article, he shall issue his warrant for the arrest of the offender or offenders, which warrant shall be Issue warrant for arrest.

directed to the sheriff or any constable of the county wherein the said warrant is issued, or to any Commander or Deputy Commander of the State Fishery Force.

Resisting.

Penalty.

Sec. 7. *And be it enacted*, That any person who shall resist any officer authorized under this act to make arrests, shall be deemed guilty of a misdemeanor, and upon indictment and conviction thereof in any court having jurisdiction shall be imprisoned in the jail of the county where the case is tried, or in the penitentiary, not more than two years, or fined not less than fifty nor more than five hundred dollars, in the discretion of the court; the parties tried and acquitted under this article shall have the cost of such trial paid by the Comptroller of the State out of the fund created by this article.

Duty to arrest.

Sec. 8. *And be it enacted*, That it shall be the duty of the sheriff, constable or officers of the State Fishery Force, to arrest any person found violating the provisions of this article and bring the offender before a judge of the court having criminal jurisdiction, or a justice of the peace most convenient or accessible, to be dealt with as herein provided.

Give security.

Sec. 9. *And be it enacted*, That the judge or justice of the peace before whom any person may be brought, charged under oath with violating any of the provisions of this article, shall cause the party to enter into recognizance with two sureties, approved by said judge or justice of the peace, in a sum not less than five hundred dollars, for his or their appearance at the first term of the Circuit Court thereafter, and in default thereof may commit the said party to jail.

Fines.

Sec. 10. *And be it enacted*, That the fines accruing under this article shall be paid by the sheriff, constable or officer of the State Fishery Force collecting the same, within ten days, to the clerk of the county or city where such fine may accrue, and such clerk shall account for the same to the Comptroller of the Treasury in his next quarterly return.

Condemned.

Sec. 11. *And be it enacted*, That any boat, owned wholly or in part by any non-resident, used in catching oysters in this State with scoop, dredge or similar instrument, shall be condemned by order of any Judge of the Circuit Court nearest the place of

her capture, or, if captured in Baltimore, by order of the Judge of the City Court, and shall be sold by the sheriff of the county where condemned to the highest bidder for cash, after twenty days' notice of the time and place of sale, such notice to be published at least three times in a newspaper having the largest circulation printed in Baltimore city, or in the county where condemned; one-fourth of the proceeds of such sale shall be paid to the party making the capture, except the officers of the fishery force, and the balance shall be paid into the Treasury of the State.

Proceeds of sale.

SEC. 12. *And be it enacted*, That any person who shall, without authority from the owner, catch oysters planted or bedded, shall be deemed guilty of a felony, and on conviction in the Circuit Court of the county wherein the oysters were bedded shall be sentenced to the penitentiary for a term not exceeding three years.

Guilty of a felony.

SEC. 13. *And be it enacted*, That it shall be unlawful for any person to catch oysters, except for private use, or for the purpose of replanting or bedding in the waters of this State, or for sale to the citizens of the county wherein they are caught, or the county next adjoining, between the first day of May and the first day of September in each and every year. Any person violating this section shall be deemed guilty of a misdemeanor, and fined by a justice of the peace of the county wherein the offence was committed, not exceeding fifty dollars.

Penalty.

SEC. 14. *And be it enacted*, That it shall be unlawful for any person to catch oysters on Sunday or at night, and any person violating this section shall be fined a sum not less than fifty nor more than five hundred dollars, by the judge or justice of the peace trying the case.

Sunday or at night.

SEC. 15. *And be it enacted*, That the Comptroller of the Treasury shall have painted, in black figures on white canvas, two sets of numbers, corresponding to the license, to catch oysters with scoop, dredge or similar instrument; each figure shall be twenty-two inches in length, and of proportionate width, and the figures at least six inches apart; and he shall give to each person taking out such license two numbers thereof, one of which shall be firmly sewed

Numbers.

Size.

upon the starboard side and in the middle of that part of the main sail which is above the close reef, and the other number on the port side and in the middle part of the jib which is above the bonnet and reef; these numbers shall be placed in an upright position and worn at all times during the dredging season, and shall not be concealed or defaced, and no other number shall be exposed to view or used than that which is furnished by the Comptroller. Any captain who shall violate the provisions in this section shall be deemed guilty of a misdemeanor, and upon conviction in any Circuit Court of this State shall be fined not less than fifty nor more than one hundred dollars, or imprisonment in the jail of the county where the case is tried not more than six months, in the discretion of the court; provided the court or jury trying the same shall be convinced that the provisions of this section have been intentionally violated.

Placed.

Violating.

SEC. 17. *And be it enacted*, That any resident of this State desiring to use any canoe or other boat in catching or taking oysters, for sale, with rakes or tongs, in any of the waters of this State, shall first obtain, by application to the clerk of the Circuit Court for the county wherein he may reside, a license therefor, and such license shall have effect from the first day of June in the year in which it may have been obtained, to the first day of June next succeeding; provided that such license shall not authorize the use of said canoe or boat, in taking or catching oysters in any creek, cove, river, inlet, bay or sound within the limits of any county other than that wherein the license shall have been granted, and that the boundaries of counties bordering on navigable waters shall be strictly construed, so as not to permit the residents of either county to take or catch oysters beyond the middle of the dividing channel; provided that nothing in this section shall be so construed as to prevent the citizens of Calvert and St. Mary's counties from using the waters of the Patuxent River in common, or the citizens of Queen Anne and Kent from using the waters of the Chester River in common, or the citizens of Dorchester and Wicomico from using the waters of the Nanticoke in common, or the citizens of Queen Anne and Tal-

Obtain license.

Proviso.

bot from using the waters of Wye River and the mouth thereof in common.

License to State.

Sec. 18. *And be it enacted*, That each and every license to take or catch oysters for sale with rakes or tongs shall state the name and residence of the person to whom the same is to be granted, the number, together with the length, to be obtained by top or over-all measurement of the canoe or boat licensed, the county in which the same is to be used, and the period at which said license will expire; and every applicant for such license shall pay to the clerk of the court where such license may be granted, and before the issuing and delivery of the same, according to the following rates, viz: for any boat measuring in length twenty feet or less, the sum of two dollars; measuring from twenty to twenty-five feet, the sum of three dollars; measuring from twenty-five to thirty feet, the sum of four dollars; and all over thirty feet, including sloops under Custom-House tonnage, the sum of five dollars each; and all oysters taken with rakes or tongs shall be culled upon the natural beds where they are taken; the amount received from tonging license to be paid by the clerk to the school commissioners for the public schools of the respective counties where such license is issued; provided the sum received from white tongers shall go to white schools, and the sum from colored tongers to the colored schools.

Fee for.

To make oath or affirmation.

Sec. 19. *And be it enacted*, That every applicant for license to use any canoe or other boat in taking or catching oysters with rakes or tongs shall be required to make oath or affirmation before the clerk authorized to issue the same, or some justice of the peace, on whose certificate of the taking of such oath or affirmation the clerk shall issue said license that the facts set forth in said license are strictly true; that he has been a *bona fide* resident of the county for the twelve months next preceding his application for said license that he desires and intends to use said canoe or boat only in the county in which he resides; that he will not allow the same to be used for taking oysters by non-residents of the county, and that he will comply with and obey all the laws of this State regulating the taking or catching of oysters; and every person to whom such li-

cense shall have been granted shall paint the number of his canoe or boat on the outside thereof, near the gunwale, in black figures, and not less than three inches in length and of proportionate width, in a white ground; and no number other than that in the said license shall be exposed to view on said canoe or boat; and any person failing to comply with this provision before using said boat or canoe for the purpose aforesaid shall, on conviction thereof before a justice of the peace, be fined not less than five dollars nor more than ten; and any person who may refuse to pay said fine shall be committed to the county jail for the period of thirty days or until said fine be paid.

Failing to comply.

SEC. 20. *And be it enacted*, That the Comptroller of the Treasury shall cause to be printed and delivered to the clerks of the Circuit Courts of the several counties, the requisite number of such blank licenses, and take receipts for the same as for other licenses furnished; and the said clerks shall, on the first Monday of March and December in each year, return to the Comptroller a list and account of such licenses issued by them; and no licenses to take or catch oysters with rakes or tongs shall be issued to any boat or vessel which is licensed to take or catch oysters with scoop, drag, dredge or any similar instrument.

License to be printed.

SEC. 21. *And be it enacted*, That if any person shall use any canoe or boat not licensed as required by the preceding sections of this article in taking or catching oysters with rakes or tongs except for private use, he shall, upon conviction thereof before a justice of the peace for the county wherein the offence has been committed, be fined not less than twenty nor more than one hundred dollars, and in case of a refusal to pay said fine said party shall be committed to the county jail for six months or until said fine be paid.

Prohibited

SEC. 22. *And be it enacted*, That all moneys arising from the sale of licenses or from fines, penalties and forfeitures imposed under this article shall, upon warrant of the Comptroller, be paid into the Treasury and placed to the credit of the oyster fund; and the Comptroller is hereby required to state in his annual report particularly the receipts and expendi-

Monies.

tures on account of said fund, and the balance standing to the credit of the State at the time of making such report.

Sec. 23. *And be it enacted*, That the owner or owners of any land bordering on any of the navigable waters of this State, the lines of which extend into and are covered by said waters, shall have the exclusive privilege of using the same for protecting, sowing, bedding or depositing oysters or other shell-fish within the lines of their own land; and any owner or owners of land lying and bordering upon any of the waters of this State shall have power to locate and appropriate in any of the waters adjoining his, her or their lands, five acres, for the purpose of protecting, preserving, depositing, bedding or sowing oysters or other shell-fish; and that any other citizen of the State shall have power to locate and appropriate five acres in any waters in said State not located or appropriated; provided thirty days' notice in writing shall be given the owner or owners, occupant or occupants of land bordering on said water proposed to be located, that the owner or owner, occupant or occupants may have priority of claim; and if they shall fail to locate or appropriate the water mentioned in said notice within thirty days after receiving the same, then it shall be open and free to any one under the provisions of this section; provided, also, that the said location or appropriation shall be described by stakes, bushes or other proper and visible marks, metes and bounds, which description shall be reduced to writing under the oath of some competent surveyor and recorded at the expense of the party locating or appropriating the same, in the office of the Clerk of the Circuit Court in the county wherein such lands may be located; and provided, also, that such location and appropriation shall not injure, obstruct or impede the free navigation of such waters; and provided that no natural bar or bed of oysters shall be so located or appropriated, and that six months' peaceable possession of all locations of oyster grounds, under the laws of this State, shall constitute a good and sufficient title thereto; but should any one within the six months hereinbefore provided be charged with locating or appropriating any natural bed or

Exclusive privilege.

Bordering on waters.

Proviso.

Proviso.

Proviso.

bar hereinbefore prohibited, the question may be at once submitted by any person interested to the Judge of the Circuit Court in the county where such question shall arise, who, after having given notice to the parties interested, proceed to hear the testimony and decide the case; and if decision be in favor of the party locating said five acres, said decision shall be recorded with the original record of said five acres, and shall in all cases be conclusive evidence of title thereto.

Submit to court.

SEC. 24. *And be it enacted*, That if any creek, cove or inlet, not exceeding one hundred yards at low water in breadth at its mouth make into the lands, or that if any creek, cove or inlet of greater width than one hundred yards at low water mark make into the lands, the owner or owners, or other lawful occupant or occupants, shall have the exclusive right to use such creek, cove or inlet, when the mouth of said creek, cove or inlet is one hundred yards or less in width, and when the said creek, cove or inlet is more than one hundred yards in width at its mouth at low water, the said owner or owners, or other lawful occupant or occupants, shall have exclusive right to use such creek, cove or inlet, so soon as said creek, cove or inlet, in making into said land or lands, shall become one hundred yards in width at low water, for preserving, depositing, bedding or sowing oysters, or other shell-fish, although such cove, creek or inlet may not be included in the lines of any patent.

Exclusive right to use

SEC. 25. *And be it enacted*, That the sum of twenty thousand dollars is hereby appropriated from the oyster fund of this State to purchase or build six suitable sail vessels, and arm and equip the same for the service hereinafter specified, which, together with other vessels now in the service of the State, shall be styled "State Fishery Force," and the Governor, Treasurer, Comptroller, Commissioner of the Land Office, and the Clerk of the Court of Appeals, shall constitute a Board, to be styled the Commissioners of the State Fishery Force; and they are directed to purchase, arm and equip said vessels; provided, that the Board aforesaid shall, under no circumstances, exceed the above appropriation; and the Treasurer of the State, upon the requisition of

Appropriation to build vessels.

Arm and equip.

said commissioners and the warrant of the Comptroller, is hereby directed to pay the sum or sums necessary, not exceeding this and any other appropriation hereinafter mentioned, for the purposes herein specified.

SEC. 26. *And be it enacted*, That said commissioners are empowered and directed to purchase for each of the guard boats belonging to said force one suitable cannon and such other arms and ammunition as may be necessary to make them efficient.

Purchase cannon.

SEC. 27. *And be it enacted*, That for the more efficient working of said Fishery Force, the waters of the State shall be divided into six districts, of which the waters of Somerset county shall constitute the first district; the waters of Wicomico and Dorchester counties the second; the waters of Talbot county the third; the waters of Kent and Queen Anne's counties the fourth; the waters of Anne Arundel county the fifth; the waters of Calvert, Charles and St. Mary's counties the sixth; each of which said districts shall be guarded by one sailing vessel, except the second and sixth districts, which shall be guarded by two sailing vessels, the vessel to be designated by the Commissioners of said Fishery Force, and shall be under the general supervision of the commander of said force.

Divided into districts.

SEC. 28. *And be it enacted*, That the Board of Commissioners of the State Fishery Force shall have power to appoint a suitable person to command said force, to appoint the Deputy Commanders for their respective districts from persons of the counties whose waters comprise the different districts, who shall be commissioned by the Governor, and the said Commander and Deputy Commanders shall have power to appoint their subordinates and select their crews; and the term of office of said Commander and Deputy Commanders shall be for two years, unless sooner removed for incompetency or neglect of duty; and if any of said officers shall fail in the discharge of his duty, by reason of collusion with parties interested in violating any of the provisions of this act, he shall be guilty of a misdemeanor, and on indictment and conviction in a court of law shall be fined or imprisoned at the discretion of the court.

Power to appoint.

Term of office.

To remove.

SEC. 29. *And be it enacted*, That the Board of Commissioners of the State Fishery Force shall have the power to remove any officer of said force for neglect of duty or incompetency; and any officer commanding in said force shall have the power to remove any subordinate under his command and appoint a person to fill the vacancy whenever the interest of said service may, in his judgment, require him to do so.

Keep in good order.

SEC. 30. *And be it enacted*, That the said Board of Commissioners shall have power to keep the steamer and said vessels in good order; and the Treasurer of the State, upon requisition of said Commissioners and the warrant of the Comptroller, is hereby directed to pay the sum or sums necessary to carry out the provisions of this section.

Charge of the steamer.

SEC. 31. *And be it enacted*, That the Commanding Officer, who shall have charge of the steamer, may be selected from the State at large, but that the Deputy Commanders shall be selected from the districts in which they are to serve.

Constantly on duty.

Report.

SEC. 32. *And be it enacted*, That the Commanding Officer be, and he is hereby required, to keep his vessel constantly on duty when circumstances will permit, and that every locality where a violation of the law is likely to occur shall be visited as often as the duties of the force and condition of the vessel will allow, and that every three months a report shall be made to the Commissioners of the Fishery Force of all official action taken under the law, and of all moneys received for license issued to parties engaged in carrying oysters taken in this State, which, on warrant of the Comptroller, shall be paid into the Treasury.

Duty of Deputy Commanders.

Report.

SEC. 33. *And be it enacted*, That it shall be the duty of the Deputy Commanders to confine themselves ordinarily to their several districts, but it shall be competent for them to enforce any of the provisions of this act in any waters adjacent to their districts when a violation of the same shall come to their knowledge; and that they shall report quarterly to the Comptroller the amount of moneys received for licenses issued to persons engaged in carrying oysters taken in this State, and on receiving his warrant shall pay the same into the Treasury.

SEC. 34. *And be it enacted*, That the Commanding Officer and Deputy Commander of said force shall, before entering upon the discharge of their duties, take, before one of the Judges of the Circuit Court, the oath prescribed by the Constitution, and shall enter into bond to the State of Maryland in the sum of three thousand dollars, to be approved by said judges, for the faithful performance of their duties as prescribed in this act. Give bond.

SEC. 35. *And be it enacted*, That the salary of the commanding officer in charge of steamer shall be two thousand five hundred dollars per annum, and he shall have power to appoint one officer at twelve hundred dollars per annum, one engineer at twelve hundred dollars per annum, and one officer at nine hundred dollars per annum, three seamen at thirty dollars per month, two seamen at twenty-five dollars per month, one fireman at thirty-five dollars per month, one fireman at thirty dollars per month, one fireman at twenty-five dollars per month, one steward at twenty-five dollars per month, one cook at twenty-five dollars per month; and each Deputy Commander shall receive a salary of twelve hundred dollars per annum, and shall have power to appoint one officer at a salary of eight hundred dollars per annum, and three seamen at a salary of forty dollars per month, each to be selected from the district in which they are to serve. Salaries.

SEC. 36. *And be it enacted*, That the officers and crew of the steamer aforesaid shall each receive one ration per day of the quality and quantity such as is allowed by law to the officers and crew of the Revenue Marine of the United States, but no rations shall be allowed to officers or crews of the sailing vessels. Rations.

SEC. 37. *And be it enacted*, That the officers and crew aforesaid shall be paid monthly by the Treasurer, upon warrant of the Comptroller, and the certificate of commanding officers that their duties have been performed as required by law; and the Board of Commissioners of the State Fishery Force shall have power to appoint some suitable person to perform the duty of clerk to said commissioners and allow such compensation to said clerk as in their judgment may be proper; provided the amount so paid does not exceed five hundred dollars per annum. Shall be paid monthly.

Not to affect.

SEC. 38. *And be it enacted*, That nothing contained in this act shall affect any suits, actions, presentments or indictments now pending before any tribunal in this State which have been instituted under the provisions of the article hereby repealed.

Not to apply.

SEC. 39. *And be it enacted*, That nothing in this act shall be construed so as to apply to Worcester county.

Construe.

SEC. 40. *And be it enacted*, That nothing in this act shall be construed to prohibit vessels from seeking harbors in any waters of this State.

Laws of 1878, *Chapter* 471.

When unlawful to catch oysters.

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That it shall not be lawful for any person or persons to take or catch oysters for any purpose, in any manner, or with any instrument whatever, in the waters of the Patuxent river within the boundaries of Calvert county, between Point Patience and Sheridan's Point, in Calvert county, and between Town Point and Long Point, in Saint Mary's county, from the first day of May to the first day of October in each year after the passage of this act; provided, however, that this act shall not be construed to prohibit the citizens of Calvert county or Saint Mary's county from taking from the waters thereof oysters for private use, or for the purpose of replanting or bedding in the waters of said counties, or for sale to the citizens of the county wherein they are caught.

Issue warrant for arrest.

SEC. 2. *And be it enacted*, That upon information given upon oath to any justice of the peace in and for the counties aforesaid of any violation of the provisions of this act, the said justice of the peace shall issue his warrant for the arrest of the offender or offenders, and the seizure of the canoe or boat in his or their possession, or used in the commission of the offence, together with the tackle, instruments and all things on board at the time of the commission of the offence, which warrant shall be directed to the sheriff or any constable of the county, and shall be returnable in five days from the issuing thereof.

SEC. 3. *And be it enacted*, That the justice of the peace before whom such warrant is returnable shall,

upon the return thereof, docket a case in the name of the State against the person or persons arrested and the property seized by virtue of said warrant; and if upon trial the said person or persons are guilty of violating the first section of this act, he shall render judgment, either imposing a fine upon each person so guilty of not less than twenty-five dollars or more than one hundred dollars, or condemning the canoe or boat in possession of the offender or offenders, or used in the commission of the offence, together with all the tackle, instruments and all things on board at the time of the commission of the offence, or used or employed in the commission thereof, to be sold at public auction for cash by the sheriff or constable seizing the same, after ten days' notice given publicly of the time, place, manner and terms of sale, set up at the court house door of said county; the proceeds of said sale, after paying the costs of proceedings had, shall go one-fourth to the sheriff or constable, one-fourth to the informer, and the remaining half to the County Commissioners for public road purposes.

Docket case in name of State.

Fine—how disposed of

Sec. 4. *And be it enacted*, That any party or parties against whom a justice of the peace shall have rendered judgment under the provisions of this act may, at any time within ten days from the rendition thereof, appeal from such judgment to the Circuit Court of Calvert county or Saint Mary's county; but no execution or sale shall be stayed unless the party appealing shall give bond to the State of Maryland in double the amount of the fine imposed or value of the property condemned, with surety to be approved by said justice, and with condition to prosecute such appeal with effect, and to pay the parties entitled to the same the value of the property condemned or amount of fine imposed, and all costs in case such judgment shall be affirmed; and in all cases of appeal each party shall be entitled to trial by jury.

Right of appeal.

CRAIGHILL CHANNEL.

Laws of 1870, *Chapter* 405.

Section 1. *Be it enacted by the General Assembly of Maryland*, That it shall not be lawful for any

Not to catch oysters.

person or persons to rake, drag or dredge for oysters within five hundred yards of either edge of the new channel at the mouth of Patapsco river, known as the "Craighill Channel," extending from the Seven Foot Knoll to the mouth of Magothy river.

Forfeit for violation.

Fine.

SEC. 2. *And be it enacted*, That any person or persons violating the first section of this act shall forfeit his boat or vessel, and it shall be lawful for any justice of the peace of the county or city in which such person or persons shall be arrested, to try such person or persons, and on conviction to condemn said boat or vessel and sell the same on five days' notice, and fine the said offender or offenders a sum not less than five nor more than twenty-five dollars for each and every offence, and the said justice of the peace shall pay over one-half of said fines and forfeitures to the informer, and the other half to the School Board of said county or city.

PUBLIC LOCAL LAWS.

BALTIMORE CITY.

Section 494 *of Article* 4 *of the Code of Public Local Laws is amended by Chapter* 368 *of Laws of* 1864.

Laws of 1864, *Chapter* 368.

SECTION 1. All oysters carried to the city of Baltimore for sale shall be sold by the sealed half bushel, or sealed bushel and half measure, and each and every person offending against the provisions of this section shall be subject to a fine of fifty dollars for each and every offence, to be recovered before a justice of the peace of the city of Baltimore, by action of debt in the name of the State of Maryland, one-half to the informer and the other half to the use of the State. Fine.

Chapter 193 *of Laws of* 1872 *is repealed and re-enacted by Chapter* 221 *of Laws of* 1874.

Laws of 1874, *Chapter* 221.

SECTION 1. All oysters in the shell disposed of in the city of Baltimore, or in the port of Crisfield, or at any oyster packing establishment in this State, shall be measured in an iron circular tub, of any capacity from one-half bushel to three bushels, as may be agreed upon between the buyer and seller; said measure shall contain in quantity for each bushel thereof, according to the following dimension, that is to say: sixteen and one-half inches across from inside to inside at the bottom, eighteen inches across from inside to inside at the top, and twenty-one inches diagonal from the inside chime to the top, and the same shall be even or struck measure; all oysters in the shell sold in the city of Baltimore shall be measured by a licensed measurer. Any Oysters measured. Dimensions of measure.

person may obtain a license therefor from the Clerk of the Court of Common Pleas, by paying therefor ten dollars and taking an oath before said clerk for the faithful performance of his duty; said license shall hold good for one year. A measurer shall receive for his services one-half cent per bushel, to be paid equally by the buyer and seller. Any person or persons violating the provisions of this act shall be deemed guilty of a misdemeanor, and on conviction, shall be fined not less than twenty nor more than fifty dollars for each offence, and imprisoned until the fine and costs are paid.

License for.

Violating.

Sec. 2. The measure provided for in section one of this act shall be inspected and stamped by the proper officer in the city of Baltimore, and it shall be unlawful to use any other measure. Any person violating this section shall be deemed guilty of a misdemeanor, and upon conviction shall be fined not more than fifty dollars for each offence and imprisoned until fine and costs are paid; provided, however, that nothing in this act shall be construed to apply to oysters shipped in the barrel on any steamboat which are to be sold in the barrel.

Measure to be inspected.

DORCHESTER COUNTY.

Chapter 81 *of Laws of* 1872, *which repealed and re-enacted with amendments Chapter* 129 *Laws of* 1870, *as repealed and re-enacted by Chapter* 214 *Laws of* 1874, *which is repealed and re-enacted by Chapter* 325 *Laws of* 1878.

Laws of 1878, *Chapter* 325.

Section 1. *Be it enacted by the General Assembly of Maryland*, That the act passed at the January session, eighteen hundred and seventy-four, relating to catching oysters with scoops or light dredge in the waters of Dorchester county, be and the same is thereby repealed and re-enacted to read as follows:

Repealed and re-enacted.

Sec. 2. *And be it enacted*, That it shall be lawful for citizens of Dorchester County to catch oysters with scoop or light dredge in boats not exceeding ten tons burthen, according to rules of Custom House measurement, in Honga river, Hooper's straits, Par

Where oysters may be caught.

bay, and that part of Fishing bay which lies to the southward and westward of a straight line drawn from the middle of the mouth of Tedious creek to Clay Island Light House, and in all the waters to the southward and eastward of Clay island, in Dorchester county, and adjoining the Wicomico lines up to Sandy island; provided that no boat or boats licensed under the provisions of this act shall work within two hundred yards of the shore; and the Board of County Commissioners for Dorchester county shall purchase two buoys of proper size and have them properly anchored on said straight line between Tedious creek and Clay Island Light House, and the captain of the oyster sloop of the second district shall place them in position.

Place proper buoys.

Sec. 3. *And be it enacted*, That the residents of said county be allowed to catch oysters with scoop or light dredge in the waters above named, by obtaining from the Clerk of the Circuit Court for said county, a license, which shall have effect from the first of September to the first of the next ensuing September of each year, and provided that said license shall not authorize the taking of oysters, as aforesaid, between the first day of May and the fifteenth day of September.

Must obtain license.

Sec. 4. *And be it enacted*, That every license to catch oysters with scoop or light dredge shall state the name and residence of the person to whom the same is to be granted, the number beginning with two hundred, together with the full or true tonnage of said boat or vessel, according to the rule of Custom House measurement, and every owner of a boat or vessel shall pay two dollars per ton for every ton said boat or vessel shall measure according to Custom House rule of measurement.

State name and residence.

Sec. 5. *And be it enacted*, That the Board of School Commissioners of Dorchester county shall appoint a competent person to measure all boats and vessels under ten tons licensed under this act, according to the rules of measurement now in use by the Custom House of the United States.

Rules of measurement.

Sec. 6. *And be it enacted*, That the measurer appointed under this act shall enter into bonds to Dorchester county, in the sum of five hundred dollars, for the faithful performance of his duty, and shall

Compensation.

be allowed as a fee for the measurement of each boat the sum of fifty cents per ton for every ton said boat or vessel may measure.

Make oath or affirmation.

SEC. 7. *And be it enacted*, That any applicant for a license under the provisions of this act shall be required to make oath or affirmation before the Clerk of the Circuit Court of said county, or before any justice of the peace of said county, upon whose certificate of the taking of such oath or affirmation the said clerk may issue said license as hereinbefore provided; the applicants shall set forth in said oaths or affirmations, before obtaining said license, that he has been a *bona fide* resident of said county for the twelve months next preceding his application for said license, and that he intends to use said boat or vessel only in said county, and that he will comply with and obey all laws of this State regulating the catching of oysters; and any person to whom said license shall have been granted shall paint the number of his boat on each beam, near the gun-wales, or a white field with black letters, seven inches in length, and any person refusing to comply with this provision shall, on conviction before a justice of the peace for said county, be fined not less than five and not more than twenty dollars and costs, said fine to be paid into the treasury of the public school fund for said county.

To comply with laws.

Right of appeal.

SEC. 8. *And be it enacted*, That any person who shall use any boat, canoe or other vessel without having been licensed as hereintofore provided, shall, upon conviction thereof before a justice of the peace, be fined not less than twenty-five or more than one hundred dollars, or forfeit the boat, canoe or vessel so offending, in the discretion of the justice trying [trying] the same; provided that an appeal to the Circuit Court, with bond and approved security, shall be granted at any time within twenty days from the rendering of such decision by said justice of the peace.

Fines to be paid to sheriff.

SEC. 9. *And be it enacted*, That all moneys arising from fines or forfeitures under this act, after the deduction of all costs, shall be paid by the offender directly to the sheriff, or a deputy sheriff of the county, if present, if not, to the justice, and by them paid into and credited to the public school fund of

said county, and the said offender shall stand committed until the fine and costs are paid, or appeal is taken as hereinbefore provided; and all justices of the peace before whom fines are imposed under this act shall report the amount of the same to the treasurer of the school commissioners within thirty days thereafter, under penalty of fine of double the amount thereof, in case of neglect or refusal, upon indictment and conviction thereof in the Circuit Court for said county.

Report amount.

Sec. 10. *And be it enacted*, That any master or owner of a canoe, boat or vessel, or non-resident, who shall take oysters with scoops, scrapers or light dredge, or other instruments, in the waters of said county now reserved for tonging, shall be subject to the same penalty prescribed in section eight and nine of this act.

Penalty for violation.

Sec. 11. *And be it enacted*, That the clerk of the Circuit Court for said county shall be allowed as a fee for each license issued under this act the sum of fifty cents, and shall be required to pay the residue of the license money into the public school fund of said county, quarterly, and to keep a correct statement of said fund on file in his office.

Fee for license.

Sec. 12. *And be it enacted*, That all boats licensed under the provision of this act, shall be privileged to take or catch oysters in the waters of the Great Choptank River where it is now lawful for boats to take or catch them with scoops or light dredge, without additional cost of license.

No additional cost of license.

Laws of 1868, *Chapter* 228.

Section 1. *Be it enacted by the General Assembly of Maryland*, That it shall not be lawful for any person or persons to take or catch oysters with rakes, drags or dredge within the waters of the Honga river, in Dorchester county, nor in the Nanticoke river at or above Roaring Point, in Dorchester and Wicomico counties, in quantities over five bushels in any one day during the three summer months, June, July and August, by any canoe, boat or vessel.

Not to drag or dredge for oysters

Sec. 2. *And be it enacted*, That any person or persons violating the first section of this act shall forfeit his canoe, boat or vessel; and it shall be law-

Forfeit.

ful for any justice of the peace of the county of Dorchester or of Wicomico county to try such person or persons, and if found guilty of a violation of the first section of this act may condemn said canoe, boat and vessel, and sell the same on five days' notice, and fine the said offender or offenders a sum not less than five nor more than twenty dollars for each and every offence, and said justice of the peace shall pay over said fines and forfeitures to the School Board of said counties to be used in building and repairing school houses in the county where the justice of the peace resides.

Section 1 *of Chapter* 437 *of* 1874 *is repealed and re-enacted by Chapter* 405 *Laws of* 1876, *which is repealed and re-enacted with amendments by Chapter* 359 *Laws of* 1878.

Laws of 1874, *Chapter* 437.

Make oath.

SECTION 2. *And be it enacted*, That the owner of such boat shall make oath before the said clerk that he is the *bona fide* owner of such boat, which boat shall be described in the license, that he has been a resident of the county in which his application is made for twelve months; that there is no lien on said boat held by a non-resident, and that such boat is not held with an intention to violate the provisions of this law; and shall also make oath as to the tonnage of such boat; and the master and crew of such boat shall each make oath before said clerk that he has been a resident of the said county for twelve months next preceding the time of taking such oath.

Constituted Officers.

SEC. 3. *And be it enacted*, That all owners and masters of boats licensed under this article are hereby constituted officers of the county, and are hereby clothed with authority to arrest any and all violators of this article, and to take such violators before any judge or justice of the peace, to be dealt with as hereinafter provided; and for the purpose of making such arrests are hereby clothed with the power to summon the *posse comitatus* to their aid.

SEC. 4. *And be it enacted*, That upon information, given upon oath, to any justice of the peace of said counties of any violations of this act, the said justice

of the peace shall issue his warrant for the arrest of the offender or offenders, and the seizure of the boat and furniture on board, which warrant shall be directed to the sheriff or any constable of the county, or any officer created by this act, or to any officer of the State Fishery Force. Issue his warrant.

Sec. 5. *And be it enacted*, That all money arising from fines and forfeitures imposed by this act shall be paid to the sheriff or any constable of the county, and by him paid, one-half to the informer and person making the arrest, and the other half monthly to the county commissioners of the county; and the said county commissioners are hereby authorized to use such money, together with the sums received for license under this act, which sums the clerk is hereby directed to pay over monthly to the said county commissioners, after deducting therefrom his usual fees for issuing license in providing proper police officers for the proper enforcement of the provisions of this act; and in case of a surplus remaining over at the end of each fiscal year of the county it shall be placed to the credit of the school fund of said county. Shall be paid to the sheriff. Pay over monthly.

Sec 6. *And be it enacted*, That the said county commissioners of each county shall, before the first day of August in each year, furnish the clerk of each of their respective counties two hundred blank certificates of license, to be filled up by said clerks with the description of the boat and crew, and number of the boat, and name of person obtaining the license; and all boats licensed under this act shall have the number of said license painted on each side of the bow of such boat, in black figures, to be on a white ground of a size not less than five inches in length and also painted upon two pieces of canvas, one of which shall be sewed upon the starboard side of the jib, and the other upon the port side of the mainsail of such boat, and such figures shall not be less than seven inches in length; and the licenses for Talbot county shall be numbered from one upwards; and those for Dorchester county from two hundred upwards. Furnish blank certificates. Paint numbers.

Sec 7. *And be it enacted*, That any person who shall violate any of the provisions of the preceding sections shall be deemed guilty of a misdemeanor, Violation.

and, upon conviction thereof by any judge of the circuit court, or a justice of the peace for either of said counties before whom such case may be tried, shall be fined not less than twenty-five nor more than one hundred dollars, or forfeit the boat or vessel in possession of the party offending, together with the papers, furniture and tackle on board, in the discretion of the judge or justice hearing such case.

Penalty for violating.

Sec. 8. *And be it enacted*, That nothing in this act shall be construed to prevent the residents of Dorchester county, who have been licensed to catch oysters in the waters of Fishing Bay and Hongo River with scrapers, from enjoying the privileges of this act.

Be construed.

Sec. 9. *And be it enacted*, That the Board of County Commissioners of Talbot county shall appoint a competent person to measure all canoes or other boats authorized to catch oysters under this act in the waters of Talbot county, according to the rule now in use by the custom-house of the United States; said measurer to receive as a fee for his services fifty cents per ton for each ton the boat may measure; to enter into bond to the county aforesaid, in the sum of five hundred dollars, for the faithful performance of his duty, and to hold his office during the term of said commissioners.

Appoint a competent.

Give bond.

Laws of 1876, *Chapter* 405.

Section 10. *And be it enacted*, That any resident of said counties desiring to use any canoe or other boat in catching or taking oysters for sale with rakes or tongs in the said Choptank river shall first obtain, by application to the Clerks of the Circuit Courts of said counties, a license therefor, and such license shall have effect from the first day of June in the year in which it may have been obtained, to the first day of June succeeding, and shall authorize the use of said canoe or boat in taking or catching oysters on either side of the dividing channel of said river, for sale to any person; provided that nothing herein contained shall be so construed as to conflict with the rights of owners or occupants of lands bordering on said river as are secured and protected under existing laws.

Obtain license.

Proviso.

SEC. 11. *And be it enacted*, That this act shall have full force and effect from the first day of June, eighteen hundred and seventy-six, until the first day of June, eighteen hundred and eighty. Full force and effect.

Laws of 1876, *Chapter* 396.

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That it shall be unlawful to take or catch oysters with tongs, rakes or any other instrument in the waters of Dorchester county in the months of June, July and August of each and every year; provided that five bushels per week may be taken for the use of each family. Unlawful. Proviso.

SEC. 2. *And be it further enacted*, That any person or persons violating the provisions of the preceding section shall, upon conviction thereof, forfeit and pay the sum of ten dollars and the forfeiture of boat or canoe used in said violation, and for every subsequent violation a fine of twenty dollars shall be imposed and the forfeiture of boat and canoe employed in the violation of this act, the same to be recovered before any justice of the peace within said county, one-half of all fines, including the money arising from the sale or sales of boats or canoes forfeited shall be awarded to the informer or informers, and the remainder to be paid into the free school treasury of Dorchester county, for the use of said schools; provided nothing in the two preceding sections of this act, or any part thereof, shall apply to catching oysters in either the Great or Little Choptank rivers or their tributaries in Dorchester county. Penalty for violating.

SEC. 3. *And be it enacted*, That all boats or canoes captured and condemned under the provisions of the preceding section shall be sold at public auction to the highest bidder for cash, after giving ten days' notice of the time and place of sale in such manner as may be directed by the justice of the peace making the condemnation. Sold at public auction.

Laws of 1878, *Chapter* 359.

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That chapter four hundred and thirty-seven of the Acts of the General Assembly of Maryland, passed at January session, eighteen hundred Repealed and re-enacted.

and seventy-four, and chapter four hundred and five of the acts passed at January session, eighteen hundred and seventy-six, relating to the catching of oysters with scoop, scrape or dredge in the waters of Dorchester and Talbot counties, be and the same are hereby repealed and re-enacted with amendments, as follows:

Issue license.

SEC. 2. *And be it enacted*, That the Clerk of the Circuit Court of Talbot or Dorchester county shall, upon the application of any person who has been a resident of such county for twelve months next preceding such application, and to no other person, issue a license to such resident to employ any boat of a capacity of ten tons or under, such capacity to be ascertained by Custom House measurement, in taking or catching oysters with dredge, scoop or scrape in the waters of the Choptank river in said counties, for sale to any person between the fifteenth day of September in each year and the first day of June next following; provided that nothing in this act shall authorize the taking of oysters with dredge, scoop or scrape, above a straight line drawn from Oyster Shell Point on the Dorchester shore to the Talbot shore, immediately opposite, or in any tributaries of said river above or below said Oyster Shell Point; and provided further, that the applicant shall pay to said clerk, before the issuing of said license, the sum of two dollars per ton, according to the capacity of the vessel to be licensed, which said license shall be good for twelve months from the day of its issue; and until such license is obtained it shall be unlawful to use or employ any vessel in taking or catching oysters as hereinbefore described; provided that the waters of Talbot county lying between Black Walnut Point and a line drawn from Tilghman's Point to the southwest point of Parson's Island, except the waters between Poplar Island and the main land lying within a line drawn from a point of land on the north side of Ferry cove, known as Lowe's Point, to the northern extremity of Poplar Island on the north to a line from the northwest extremity of Tilghman's Island to the southern extremity of south bar of Poplar Island on the south, which are hereby reserved for the use of tong men, shall be opened to the citizens of Talbot county,

When unlawful.

licensed under this act, between the fifteenth day of September in each year, and the first day of May next following, but it shall be unlawful to take oysters with scoop or dredge in any other waters of Talbot county; provided, also, that the waters of Choptank river lying north of a straight line running from Benoni's Point to Clora's Point are hereby reserved for tong men, and it shall not be lawful to catch oysters with scoop, scrape or similar instrument to the northward of said line.

What is reserved.

Sec. 3. *And be it enacted*, That the owner of such boat shall make oath before the said clerk that he is the *bona fide* owner of such boat, which boat shall be described in the license; that he has been a resident of the county in which his application is made for twelve months; that there is no lien on said boat held by a non-resident, and that such boat is not held with an intention to violate the provisions of this law; and shall also make oath as to the tonnage of such boat; and the master and crew of such boat shall each make oath before said clerk that he has been a resident of the said county for twelve months next preceding the time of taking such oath.

Term of residence.

Sec. 4. *And be it enacted*, That all owners and masters of boats licensed under this article are hereby constituted officers of the county, and are hereby clothed with authority to arrest any and all violators of this article, and to take such violators before any judge or justice of the peace, to be dealt with as hereinafter provided; and for the purpose of making such arrests are hereby clothed with the power to summon a *posse comitatus* to their aid.

Summon *posse comitatus*.

Sec. 5. *And be it enacted*, That upon information given upon oath to any justice of the peace of said counties of any violation of this act, the said justice of the peace shall issue his warrant for the arrest of the offender or offenders, and the seizure of the boat and furniture on board, which warrant shall be directed to the sheriff or any constable of the county, or any officer created by this act, or to any officer of the State Fishery Force.

Arrest offenders.

Sec. 6. *And be it enacted*, That all money arising from fines and forfeitures imposed by this act shall be paid to the sheriff or any constable of the county, and by him paid one-half to the informer and per-

Fine—how disposed of

son making the arrest and the other half monthly to the County Commissioners of the county; and the said County Commissioners are hereby authorized to use such money, together with the sums received for license under this act, which sums the clerk is hereby directed to pay over monthly to the said County Commissioners, after deducting therefrom his usual fees for issuing license, in providing proper police officers for the proper enforcement of the provisions of this act; and, in case of a surplus remaining over at the end of each fiscal year of the county, it shall be placed to the credit of the school fund of said county.

Furnish blank certificates.

SEC. 7. *And be it enacted*, That the said County Commissioners of each county shall, before the first day of August in each year, furnish the clerk of each of their respective counties two hundred blank certificates of license, to be filled up by said clerks with the description of the boat and crew and number of the boat, and name of the person obtaining the license; and all boats licensed under this act shall have the number of said license painted on each side of the bow of such boat, in black figures, to be on a white ground of a size not less than five inches in length; and also painted upon two pieces of canvas, one of which shall be sewed upon the starboard side of the jib and the other upon the port side of the mainsail of such boat, and such figures shall not be less than seven inches in length; and the licenses for Talbot county shall be numbered from one upwards; and those for Dorchester county from two hundred upwards.

Length of figures.

Fine for violation.

SEC. 8. *And be it enacted*, That any person who shall violate any of the provisions of the preceding sections shall be deemed guilty of a misdemeanor, and, upon conviction thereof by any judge of the Circuit Court, or a justice of the peace for either of said counties before whom such case may be tried, shall be fined not less than twenty-five nor more than one hundred dollars, or forfeit the boat or vessel in possession of the party offending, together with the papers, furniture and tackle on board, in the discretion of the judge or justice hearing such case.

How construed.

SEC. 9. *And be it enacted*, That nothing in this act shall be construed to prevent the residents of

Dorchester county, who have been licensed to catch oysters in the waters of Fishing bay and Hungary river with scrapers, from enjoying the privileges of this act.

Appoint measurer.

SEC. 10. *And be it enacted*, That the Board of County Commissioners of Talbot County shall appoint a competent person to measure all canoes or other boats authorized to catch oysters under this act in the waters of Talbot county, according to the rule now in use by the Custom House of the United States, said measurer to receive as a fee for his services fifty cents per ton for each ton the boat may measure, to enter into bond to the county aforesaid, in the sum of five hundred dollars for the faithful performance of his duty, and to hold his office during the term of said commissioners.

Must obtain license

SEC. 11. *And be it enacted*, That any resident of said counties desiring to use any canoe or other boat in catching or taking oysters for sale with rakes or tongs in the said Choptank river, shall first obtain, by application to the Clerks of the Circuit Courts of said counties, a license therefor, and such license shall have effect from the first day of June in the year in which it may have been obtained to the first day of June succeeding, and shall authorize the use of said canoe or boat in taking or catching oysters on either side of the dividing channel of said river for sale to any person; provided that nothing herein contained shall be so construed as to conflict with the rights of owners or occupants of lands bordering on said river as are secured and protected under existing laws.

CALVERT COUNTY.

Laws of 1870, *Chapter* 188.

Not to catch oysters.

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That it shall be unlawful for any person or persons to catch oysters for sale in the waters of Saint Leonard's Creek, Island Creek and Battle Creek, in Calvert county, except persons who have imbedded or planted, or who may hereafter imbed or plant oysters in said waters.

SEC. 2. *And be it enacted*, That on information given under oath of any violation of this act to any

Justice of the peace to issue.

justice of the peace of Calvert county, he shall forthwith issue his warrant directed to the sheriff, or any constable or military officer, requiring either of them to whom it may be directed to summon the *posse comitatus*, if necessary, and proceed forthwith to arrest the party or parties alleged to have been engaged in violating this law, and to seize and take possession of any canoe, boat or vessel, together with all their tackle and apparel, and any article on said boat at the time belonging to said party or parties and used by them in violating the law.

Take possession.

Hearing of offenders.

Sec. 3. *And be it enacted*, That the sheriff, constable, or military officer who has made the arrest, shall forthwith bring the offender or offenders before some justice of the peace of the county for a hearing, and said justice of the peace shall either give the case an immediate hearing, or at the instance of the party shall appoint some early day, within the next five days thereafter, to hear the case, the party charged giving such good and sufficient bail as said justice shall require for his attendance; and on conviction of the offender or offenders the said justice shall decree a forfeiture of the canoe, boat or vessel, together with all the tackle and apparel, and order the same to be sold by the officer making the arrest, who shall sell the same, on five days' notice, to the highest bidder, subject to an appeal to the Circuit Court for Calvert county, and after the payment of all the expense attending the arrest and prosecution of the suit he shall retain one-fourth of the balance himself, distributing one-fourth among the parties assisting in making the arrest, and pay over the remaining one-half to the School Fund of the county, to be used in the repair of old and the erection of new public school houses.

Forfeiture.

Shall sell.

Laws of 1878, *Chapter* 163.

Not lawful

Section 1. *Be it enacted by the General Assembly of Maryland*, That it shall not be lawful for any person to take or catch oysters for sale with rakes, tongs or any other instrument whatever in the waters of Mill Creek, Back Creek or Saint John's Creek, in Calvert county, for the period of three years from the passage of this act, except from land in said waters located and appropriated, or which may be

hereafter located and appropriated by virtue of any act or acts of the General Assembly of Maryland, authorizing the location and appropriation thereof for the purpose of protecting, preserving, depositing, bedding or sowing oysters, and any person violating the provisions of this law shall be deemed guilty of a misdemeanor, and shall upon conviction thereof before a justice of the peace of said county be fined a sum not less than twenty nor more than fifty dollars.

Penalty.

SEC. 2. *And be it enacted*, That for the purposes of this act a line drawn from the steamboat wharf on Solomon's Island, and running in a northeasterly direction to Township Point on Rousby Hall farm, shall be the dividing line between the mouth of Mill Creek and the Patuxent River.

A line drawn from.

KENT COUNTY.

Section 1, *Chapter* 359, *Laws of* 1872, *is modified by Chapter* 381, *Laws of* 1876. *See Queen Anne's County.*

Laws of 1872, *Chapter* 359.

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That any resident of either Queen Anne's or Kent county owning or having in his possession any canoe or other boat under Custom House tonnage, and desiring to use said boat or canoe in taking or catching oysters for sale with rakes or tongs, in any of the waters of the aforesaid counties, shall first obtain, by application to the Clerk of the Circuit Court for that county wherein he may reside, a license, such as is now prescribed by the General Law, and which said license shall give him a right to take or catch oysters in the waters of either Queen Anne's or Kent county; and such license shall have effect from the first day of October in the year in which it shall have been obtained to the first day of October next succeeding, subject to the provisions of the General Law as to the time in which oysters shall be caught or taken with tongs; *provided*, that such license shall not authorize the use of said canoe or boat in taking or catching oysters in any creek, river, cove, inlet, bay or sound within the limits of any county other than Queen

Tongsmen allowed to catch oysters.

By obtaining a license.

Proviso.

Anne's and Kent; and that the boundaries of the counties bordering on navigable water shall be strictly construed so as not to permit the residents of either of these counties to take or catch oysters beyond the channel of the creeks or rivers lying between these and other contiguous counties; and *provided further*, that this act shall not authorize the taking or catching of oysters from grounds already located or appropriated for the purpose of preserving, depositing or bedding the same in the waters of said counties, under the provisions of the General Laws.

QUEEN ANNE'S COUNTY.

Laws of 1876, *Chapter* 381.

Boundary line.

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That the following lines, to wit: from the south point of Wye Island to the southeast point of Bennett's Point, thence to the south point of Parson's Island, be and the same are hereby established as a boundary for the protection of the oyster grounds in that branch of Wye river known as "Back Wye," and the oyster grounds lying on the land or Queen Anne's side of that part of said boundary extending from the south east point of Bennett's Point to the south point of Parson's Island.

Not lawful.

SEC. 2. *And be it enacted*, That it shall not be lawful for any non-resident of Queen Anne's county to catch by the means of tongs, or by any other means, or in any manner to molest oysters, the protection of which is contemplated by this act, to wit: oysters within or on the land or Queen Anne's side of the boundary herein above specified.

Opened in common.

SEC. 3. *And be it enacted*, That the dividing waters of Wye river, and the waters of St. Michael's river lying west of the boundary line described in section one of this act, and the waters around Herring Island, are hereby opened to the citizens of Queen Anne's and Talbot counties in common, for the purpose of taking or catching oysters with rakes or tongs.

Be lawful.

SEC. 4. *And be it enacted*, That it shall be unlawful for any person to take or catch oysters with scoop, scrape or any similar instrument in the waters

of Queen Anne's county lying west of Kent Island, between Kent Point and Cove Point, within four hundred yards of the shore.

Sec. 5. *And be it enacted*, That any person who shall violate this act, upon conviction thereof before a justice of the peace for Queen Anne's county, shall be fined not less than twenty nor more than one hundred dollars, and upon the refusal and failure to pay said fine said party shall be committed to the county jail until said fine shall be paid; provided that the said confinement in jail shall not exceed six months. Penalty.

Sec. 6. *And be it enacted*, That this act shall take effect from the date of its passage, and all acts or parts of acts inconsistent with this act be and the same are hereby repealed. In force. Repealed.

Also see Kent County.

SOMERSET COUNTY.

Code of Public Local Laws, Article 19.

Section 91. It shall not be lawful for any person to take oysters within the waters of Somerset county for the purpose of manuring land.

Sec. 92. It shall not be lawful for any person in said county, or any person whatsoever, to purchase any oysters for the purpose of manuring land from any person whom they know to have caught the same within the waters of said county.

Sec. 93. Any person violating the provisions of either of the last two preceding sections shall be liable to a penalty of not less than ten nor more than twenty dollars, to be imposed, upon conviction thereof before a justice of the peace of the county, one-half to the informer and the other half for the use of the school fund of said county.

Sections 94, 95 *and* 97 *of Article* 19 *Code of Public Local Laws are amended and re-enacted by Chapter* 129 *Laws of* 1867.

Laws of 1867, *Chapter* 129.

Section 94. That it shall be lawful for the citizens of said county to catch or take oysters with a scoop, drag or dredge in any of the waters of said Lawful to catch oysters.

county not parcel of any creek, cove, river or inlet, upon obtaining license therefor as hereinafter directed.

Clerk required to issue license.

Sec. 95. The Clerk of the Circuit Court for said county, upon application of any citizen of said county, shall issue a license to such citizen, authorizing him to take or catch oysters with scoops, drags or dredges in the waters of said county, subject to the provisions of this law, for one year from the date of said license, for which said license the citizen applying shall pay to the said clerk the sum of ten dollars; provided that the citizen so applying shall have first satisfied the said clerk that he has obtained from the Comptroller of the State license to take or catch oysters in the waters of the Chesapeake Bay, as required by article seventy-one of the Code of Public General Laws; and provided also the said license shall not authorize the taking or catching of oysters between the first days of June and September in each year as forbidden by said article seventy-one of the Code.

Proviso.

Code of Public Local Laws, Article 19.

Section 96. The person so applying for a license shall first be required to make oath that he is a *bona fide* owner of the vessel to be licensed, that he has been a *bona fide* citizen of the State for one year immediately preceding said application and six months a resident of the county, and that the license is intended for his use only.

Laws of 1867, *Chapter* 129.

Penalty for violation.

Section 97. Any person taking oysters within the waters of said county with a scoop, drag or dredge without license, or who is not a citizen of said county, or otherwise, contrary to any law of this State, shall be subject to all the penalties provided by law against the illegal taking of oysters in this State.

Code of Public Local Laws, Article 19.

Section 98. In all cases where a vessel or individual shall be tried, either upon appeal or otherwise, for a violation of the provisions of the code

regulating the taking or catching oysters, and shall be acquitted or discharged by the Circuit Court or by a justice of the peace for Somerset county, the county commissioners shall pay the legal costs of defending the prosecution to such individual or the owner of such vessel.

Sec. 99. Any justice of the peace, upon the oath of any credible white witness, may issue a warrant to any sheriff, constable or other officer, civil or military, and to all persons licensed under the provisions of this law, to make all arrests and seizures necessary to carry the same into effect.

Sec. 100. The clerk of the Circuit Court shall be entitled to fifty cents each for every license granted under this law.

Sec. 101. He shall pay the money arising from the issuing of said licenses to the Treasurer of the school fund of said county, on or before the first Monday of June in each year, and his official bond shall be liable for the prompt payment thereof.

Laws of 1878, *Chapter* 373.

Section 1. *Be it enacted by the General Assembly of Maryland*, That it shall be unlawful to take or catch oysters with scoops, drags or dredges, or such like instruments, in the waters of the Wicomico River in Somerset county, on the east side of a straight line from the mouth of Rock Creek to Clay Island Light House, and any person violating this act shall be liable to be tried before any justice of the peace upon being arrested on warrant from any justice of the peace of said county, and upon conviction shall be fined not less than twenty-five dollars nor more than fifty dollars for every such offence, and shall also forfeit the boat or vessel used or employed in such violation of this act; and the said boat or vessel so forfeited and condemned shall be sold by the officer making the seizure or arrests, upon ten days' notice of such sale, for cash, together with the sails and furniture of said boat or vessel and the implements on board said boat used in such illegal taking of oysters; and one-half the proceeds of said sale shall be paid to the informer and party making the said seizure, and the balance shall be paid to the use of the public schools of said county; and any

Unlawful to use scoops, &c.

Penalty for violation.

party interested shall have the right of appeal to the Circuit Court for Somerset county from the judgment of any justice of the peace trying any cause arising for the violation of any of the provisions of this act.

Right of appeal.

TALBOT COUNTY.

See Dorchester County, Laws 1874, *Chapter* 437; *Laws of* 1876, *Chapter* 405; *Laws of* 1878, *Chapter* 359.

WICOMICO COUNTY.

See Dorchester County, Laws of 1868, *Chapter* 228.

Laws of 1872, *Chapter* 241.

Section 1. *Be it enacted by the General Assembly of Maryland*, That it shall not be lawful for any person or persons to employ any canoe, boat or vessel in catching or taking oysters with scoop, scrape, drag or dredge, or any similar instrument, within the waters of Wicomico county, nor shall any person or persons take or catch oysters for sale within the waters of said county otherwise than with tongs, as restricted and regulated by the provisions of the General Oyster Law in force in this State.

Not lawful to take or catch oysters with scoops, &c.

Sec. 2. *And be it enacted*, That for the protection of the young oysters in the waters of Wicomico county, it shall not be lawful for any person or persons to convey beyond the limits of said county any oysters from the fifteenth day of May until the first day of September in each and every year.

Protection of young oysters.

Sec. 3. *And be it enacted*, That any person or persons violating the provisions of either the first or second sections of this act, shall forfeit the canoe, boat or vessel in his or their possession, together with the tackle and apparel and all things on board at the time the offence may have been committed, and shall be fined in a sum not less than fifty dollars nor more than one hundred dollars for each and every offence, and shall stand committed to jail until such fine shall be fully paid and satisfied.

Persons violating forfeit property.

Sec. 4. *And be it enacted*, That on information

under oath of any violation of the provisions of this act to any justice of the peace in Wicomico county, he shall forthwith issue his warrant to the sheriff or any constable or military officer, requiring either of them to whom it may be directed to summon the *posse comitatus* if necessary, and proceed forthwith to arrest the party or parties alleged to have been engaged in the violation of this act, and to seize and take possession of any canoe or canoes, boat or boats, vessel or vessels, together with all their tackle and apparel and all things on board of the same belonging to said party or parties or in their possession at the time of the alleged offence or offences, and used by him or them in violating this act.

Information of violation.

Seize and take possession of property.

Sec. 5. *And be it enacted*, That the Sheriff, Constable or military officer who shall make the arrest, shall forthwith bring the offender or offenders before some justice of the peace of Wicomico county for a hearing, and the said justice of the peace shall either give the case an immediate hearing or at the instance of the party or parties charged with a violation of this act shall appoint some early day within the next five days thereafter to hear the case, the party or parties charged giving such good and sufficient bail as said justice shall require for his or their attendance; and on conviction of the offender or offenders the said justice shall decree a forfeiture of the canoe, boat or vessel, together with all the tackle and apparel and property found on board, and fine such person or persons in a sum of not less than fifty nor more than one hundred dollars in each and every case, and shall have power and authority to commit to the jail of said county such offender or offenders so convicted until such fine or fines so imposed shall be fully paid and satisfied.

Officer making the arrest bring before justice of the peace.

Decree a forfeiture.

Sec. 6. *And be it enacted*, That the justice of the peace before whom any such offender or offenders shall be tried and convicted, be and he is hereby authorized to order the officer making the arrest to sell the property so seized, on five days' notice, to the highest bidder, subject to an appeal in all cases to the Circuit Court of Wicomico county, and after the payment of the expenses attending the arrest and prosecution in any such case, the officer making the

On conviction property to be sold.

arrest shall retain one-fourth of the balance himself, distribute one-fourth among the parties assisting in making such arrest and seizure, and pay over the remaining one-half to the Board of School Commissioners of Wicomico county for the use of the public schools of said county.

Duty of the commander of the Oyster Police Force.

SEC. 7. *Be it enacted*, That upon information given under oath of any violation of the provisions of this act to the commander of the "Oyster Police Force" of this State, it shall be the duty of said commander to arrest the offender or offenders, to seize and take possession of any canoe, boat or vessel, together with all their tackle and apparel and property found on board, and deliver them over to the authorities of said county to be dealt with according to the provisions of this act; and the said commander is hereby authorized to follow such alleged offender or offenders and make such arrest and seizure in any part of this State as well as within the limits of said county.

WORCESTER COUNTY.

Laws of 1868, *Chapter* 343.

Disturb terrapins.

SEC. 2. *And be it enacted*, That if any person shall disturb terrapins or their eggs within the limits of Worcester county, between the first day of May and the fifteenth day of October, he shall forfeit and pay to the State not more than fifty dollars nor less than five dollars, to be recovered on information before some justice of the peace in said county, one-half of which penalty shall be paid to the informer and the other to the State, the same to be recovered in the same manner in which small debts are recovered before justices of the peace. And in all such cases an appeal shall lie to the Circuit Court of said county, subject to the same laws and rules that govern in similar cases.

Penalty.

SEC. 3. *And be it enacted*, That if any person shall take oysters for the purpose of converting them into lime, upon conviction in the Circuit Court for Worcester county, he shall forfeit and pay to the State of Maryland the sum of five hundred dollars, and the costs and charges accruing in the prosecution of the offender.

SEC. 4. *And be it enacted*, That the offences named or contemplated by this Act may be heard by any justices of the peace of this State before whom the offending party or parties may be brought, or any justice of the peace who, upon information, shall issue a warrant for the apprehension of any offender; the said justice, upon hearing proof, may either discharge the accused or require him to enter into recognizance with sureties in double the amount of the penalty for any violation of the provisions of this act, to appear at the then session or at the next term of the said court, to answer for the offence, and to satisfy the judgment which may be rendered against him therefor, or in default thereof to be committed to the county jail until such recognizance be given. Issue warrant.

SEC. 5. *And be it enacted*, That the officer executing such warrant shall take possession of and safely keep any vessel, boat, skiff, craft or other contrivance, with her tackle and appurtenances, which to the offender may belong or is being used, or to be used, or having been used in the commission of the offence for which he is prosecuted, and shall hold the same until the recognizance required be given, and the penalties, fees and fines be paid, or until the defendant be acquitted. Safely keep.

SEC. 6. *And be it enacted*, That if judgment be given against the defendant, it shall be a part of the judgment of the court, that if the penalties and costs be not forthwith paid, all the property so seized shall be sold and the proceeds accounted for as if it were the property of the defendant seized under execution for the satisfaction of the judgment. Judgment.

SEC. 7. *And be it enacted*, That for the seizure and safe keeping of any vessel or boat, with the equipments thereof, under the provisions of this act, the officer effecting the same shall receive a fee of twenty dollars, to be taxed in the cost, and the offender to be committed to the county jail until all penalties, costs, charges and fees are paid and the judgment against him fully satisfied. Fees.

SEC. 8. *And be it enacted*, That the informer, if there be one, shall be entitled to a moiety of any fine or forfeiture imposed by this act. Moiety.

Affidavit.

SEC. 9. *And be it enacted*, That where a preceding is initiated for any violation of this act or any section thereof, on affidavit of such violation, a justice of the peace may issue his warrant for the apprehension of the offender, and it shall not be necessary therein to name the offender, the vessel or boat in his employment, and when the penalty is incurred by reason of the defendant being a non-resident the burthen of proof as to his residence shall be upon him

Fine.

SEC. 10. *And be it enacted*, That if any person shall take, steal or sell planted oysters of another, knowing them to be such, from any of the waters in this act mentioned, he shall, upon conviction in said court, be fined not less than fifty nor more than one hundred dollars, and may, at the discretion of the court, be confined in jail not less than one nor more than six months.

Section 1, *Chapter* 131 *of the Laws of* 1872 *is repealed and re-enacted by Section* 1 *A of Chapter* 77 *Laws of* 1874. *Chapter* 77 *of Laws of* 1874 *is repealed by Chapter* 277 *Laws of* 1876, *and re-enacted with amendments. Section* 6, *Chapter* 277 *Laws of* 1876 *is repealed by Chapter* 64 *Laws of* 1878, *and re-enacted with amendments.*

Laws of 1872, *Chapter* 131.

Not lawful

SECTION 2. *Be it enacted*, That it shall not be lawful for any person or persons other than citizens or actual residents of Maryland to haul or fish with any seine or seines of any description, rake or catch oysters, clams or terrapins, or plant oysters in the waters of Synepuxent Bay or any of the tributaries thereof, included in the boundaries of Worcester county.

Fish with seines.

SEC. 3. *And be it enacted*, That it shall be lawful for all citizens and residents of the State of Maryland to haul or fish with any seine or seines of any description in any of the aforesaid waters of Worcester county, *provided* that the meshes of all seines exceeding one hundred fathoms in length shall not be less than one and a half inches square, which is hereby expressly forbidden, and the use of which is hereby made and declared unlawful.

Proviso.

SEC. 4. *And be it enacted*, That it shall be and is hereby made unlawful for any person or persons to stop up the mouth of any river, creek or cove, by means of a seine or gill net, so as to prevent fish from passing in or out of said river, creek or cove. Unlawful.

SEC. 5. *And be it enacted*, That any person who shall violate any of the provisions of the preceding sections shall be deemed guilty of a misdemeanor, and upon conviction thereof before a justice of the peace, or upon indictment and conviction in the Circuit Court for Worcester county, shall be fined not less than twenty-five nor more than one hundred dollars, one-half of said fine to be paid to the informer and the residue to the school fund of the county; and in all cases of conviction of the party arrested, or sale of a boat, furniture and implements under this act, the officer making such arrest or seizure shall be entitled to a fee of twenty dollars, to be collected from the party convicted or from the proceeds of sale of said boat, tackle and implements in addition to all other costs; *provided* that this act shall not restrict or prevent traders or other persons from purchasing from or selling to non-residents the shell-fish in this act mentioned. Penalty for violating. Fine. Officer's fee. Proviso.

SEC. 6. *And be it enacted*, That if any citizen of Maryland shall be concerned or interested with any person not resident within this State in the taking, catching or planting of oysters in the waters of Synepuxent Bay or in any of the tributaries thereof included in the boundaries of Worcester county, or shall knowingly permit any person not a citizen and actual resident within this State to take, catch or plant oysters in his name, he shall be liable to the penalties and forfeitures imposed for the violation of the preceding sections of this act, and shall be proceeded against in the same manner; *provided* that nothing herein shall be construed to prevent the employment of non-residents as day laborers for the above purposes. Citizens of the State not to allow their names to be used fraudulently. Proviso.

SEC. 7. *And be it enacted*, That upon information given upon oath to any justice of the peace of Worcester county of any violations of any of the provisions of this article, the said justice of the peace shall issue his warrant for the arrest of the offender or offenders and the seizure of the canoe, boat or Information of violation.

Seizure.

vessel, together with the tackle and furniture on board, which warrant shall be directed to the sheriff or any constable of Worcester county.

Duty of sheriff.

SEC. 8. *And be it enacted*, That it shall be the duty of the sheriff or any constable of Worcester county, with or without warrant, to arrest any person or persons and to seize and take into custody any canoe, boat or vessel whenever and wherever such person or persons, canoe, boat or vessel shall be found violating or being used in violating any of the provisions of this article, and bring the offender or offenders before some justice of the peace or judge of the Circuit Court of said county.

Condemned property.

SEC. 9. *And be it enacted*, That all boats, vessels or other property condemned under the provisions of this article shall be sold by the sheriff or some constable of Worcester county, at public sale, after giving twenty days' notice of the time and place of such sale by advertisements posted in at least two public places in the vicinity of said sale, to the highest bidder for cash, and the boat, tackle and implements used by the party violating any of the provisions of this act shall be seized and taken in possession by the said constable or Sheriff, and in default of payment of the fine and costs aforesaid shall be sold at public sale as hereinafter provided, and as much of the proceeds of said sale as may be necessary applied to the payment of all fines and costs and other expenses incurred under this act.

To be sold.

Judgment.

SEC. 10. *And be it enacted*, That any party or parties against whom any justice of the peace may render a judgment under this article, either to pay a fine or of condemnation of property, may at any time, within ten days from the rendition of such judgment, appeal from such judgment to the Circuit Court of Worcester county, but no execution or sale shall be stayed unless the party appealing shall give bond with security to the State of Maryland in double the value of the property condemned or of the fine imposed, as the case may be, said security or securities to be resident or residents of Worcester county, and who shall swear or affirm that he or they are worth double the amount of the property condemned, and becomes security, for the same with condition to prosecute such appeal with effect and to

May appeal from.

pay the value of the property condemned and fine imposed and all costs attending such proceedings, in case such judgment shall be confirmed.

Persons engaged in violating shall flee.

SEC. 11. *And be it enacted*, That if any person or persons on board any canoe, boat or vessel engaged in violating any of the provisions of this article shall abandon the said canoe, boat or vessel, and flee so as to escape arrest, the officer endeavoring to make such arrest shall seize such canoe, boat or vessel, and give information of such seizure to some justice of the peace or judge of the Circuit Court for Worcester county, and it shall be the duty of the said justice of the peace or judge to docket a case in the name of the State against the said canoe, boat or vessel, and to proceed without delay with the trial of the same, and if there is sufficient proof that said canoe, boat or vessel has been used or employed in violating any of the provisions of this article, the said justice of the peace or judge shall either render a judgment of condemnation against the said canoe, boat or vessel, her tackle and furniture on board at the time of, or fine the said canoe, boat or vessel not less than twenty-five dollars, one-half of said fine to be paid to the informer and the residue to the Treasurer of the School Board of Worcester county for the use of the school fund of said county.

Docket case.

Judgment of condemnation or fine.

Disposition of fines.

SEC. 12. *And be it enacted*, That the several justices of the peace and clerk of the Circuit Court for Worcester county be and they are hereby authorized and required to pay to the Treasurer of the School Board of said county, every three months, all the money or moneys they may have in hand at such times arising from fines, penalties or forfeitures imposed under this act.

Shells not to be removed.

SEC. 13. *And be it enacted*, That no person shall, under any pretext whatever, remove or take away any shells from any of the rocks or flats whereon oysters grow within the limits of Worcester county, and any person violating this section shall be liable to a fine of twenty-five dollars to be recovered as other fines or by judgment of any of the justices of the peace of said county, one-half to be paid to the informer and the residue to the Treasurer of the School Board of Worcester county, for the benefit of the school fund of said county.

Oysters in the shell disposed of

SEC. 14. *And be it enacted*, That all oysters in the shell disposed of in the waters of Worcester county shall be measured in a sealed measure of any capacity from half a bushel to two bushels that may be agreed upon between seller and buyer, and any person offending against the provisions of this section shall be subject to a fine of twenty-five dollars for each and every offence, to be recovered before any justice of the peace of Worcester county, one-half to the informer and the other half to the Treasurer of School Board of Worcester county, for the benefit of the school fund of said county.

To be measured.

SEC. 15. *And be it enacted*, That it shall be the duty of the purchaser or seller to have said measure or measures duly inspected and sealed by the standard keeper under a forfeit of twenty-five dollars for each and every offence, to be recovered before any justice of the peace of Worcester county, one-half to the informer and the other half to the Treasurer of School Board of Worcester county, for the benefit of the school fund of said county.

Repealed.

SEC. 16. *And be it enacted*, That all acts or parts of acts inconsistent with this act be and the same are hereby repealed.

Laws of 1876, *Chapter* 277.

Repealed and conditioned.

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That chapter seventy-seven (77) of the acts passed January session, eighteen hundred and seventy-four (1874), for the protection of oysters in Sinepuxent Bay and its tributaries, is hereby repealed, but all violations of said act may be prosecuted and punished as fully as if said act had not been repealed.

Issue license.

SEC. 2. *And be it enacted*, That the clerk of the Circuit Court for Worcester county may issue to any citizen of said county a license to take or catch oysters with rakes or tongs from the waters of Sinepuxent Bay and its tributaries until the first day of May next after the issuing of said license; provided the applicant for said license shall satisfy said clerk, by his own oath or other sufficient proof, that he is a citizen of said county, and shall pay to said clerk the sum of one dollar, to be paid by said clerk to the County Commissioners of Worcester county, to be

Proviso.

expended in the procuring of seed oysters to be planted in said bay as the commissioners aforesaid may direct, but no person licensed as above, nor any other person, shall take or remove any oysters from the waters of said bay or its tributaries on any Sunday or in the night at any season, nor during the day from the first day of May to the first day of October, or any shells from the natural rocks at any time; provided that nothing herein shall be construed to forbid any person from taking or catching his or her own planted oysters at any time and with any kind of instrument; and any person violating any of the provisions of this section shall be guilty of a misdemeanor, and upon indictment and conviction therefor shall be fined not less than ten nor more than fifty dollars for each offence, with costs.

Proviso.

Penalty.

Sec. 3. *And be it enacted*, That no person shall catch, take or remove any shells or oysters from the natural beds in the waters of Sinepuxent Bay or its tributaries with scrapes, scoops, dredges or drags, or with any instrument in the working of which any other than hand power is used, and any person violating any of the provisions of this section shall, upon indictment and conviction therefor, be fined not less than fifty nor more than three hundred dollars for each offence, with cost.

Shall not catch.

Penalty.

Sec. 4. *And be it enacted*, That it shall be lawful for any citizen of Worcester county to plant, or for any resident to lay down, oysters on not exceeding five acres in any one place in any of the waters except upon the natural rocks of the said bay or its tributaries, and that no person, except the owner or his employee, shall work upon or among said planted or laid down oysters; provided that portion of the said waters so planted in be kept plainly marked with bushes, stakes or buoys, and any person maliciously removing said bushes, stakes or buoys shall be liable to the penalties of this section; and provided that nothing in this section shall effect the rights of owners of land to the exclusive use of any creek, cove or inlet, within their said lands, not exceeding one hundred yards in width at its mouth, and any person violating the provisions of this section shall be liable to be sued as for damage to any other property, and upon indictment and conviction

Be lawful.

Proviso.

Proviso.

Penalty.

for any such violation shall also be fined not less than ten dollars nor more than one hundred dollars for each offence, with costs, and in any prosecution for violating any of the provisions of this section it shall not be necessary to prove that the offender was taking up oysters, but only that he was at work in the waters within the bushes, stakes or buoys aforesaid.

Actual residents.

SEC. 5. *And be it enacted*, That no person other than actual residents of the State of Maryland shall catch clams or terrapins, or haul for or catch fish with any seine of any description in the waters of Sinepuxent Bay or its tributaries within the limits of Worcester county, and all persons violating any of the provisions of this section, upon indictment and conviction thereof, shall forfeit the boats and all seines and other instruments used in said violation,

Penalty.

be fined not less than ten dollars nor more than fifty dollars, for each offence with costs, and be imprisoned until same are paid, but said imprisonment shall in no case continue more than thirty days.

Fines—to whom paid

SEC. 7. *And be it enacted*, That the net proceeds of all sales of property forfeited and fines imposed under this act shall be paid to the Treasury of the Board of County School Commissioners of Worcester county, and used as a part of the school fund of said county.

Laws of 1878, *Chapter* 64, *repeals Section* 6 *of Chapter* 277 *of Laws of* 1876 *and re-enacts the same, as follows:*

Laws of 1878, *Chapter* 64.

Not lawful

6. It shall not be lawful for any person or persons to haul or fish in any of the waters of Synepuxent Bay or its tributaries comprised within the limits of "Worcester county," with any seine containing meshes less than one and a half inches square, un-

Seine.

less said seine shall be less than one hundred fathoms in length.

SUB-SEC. 6. Any person who shall violate any of the provisions of the preceding section shall be deemed guilty of a misdemeanor, and upon conviction thereof before a justice of the peace, or upon indictment and conviction in the Circuit Court for

Worcester county, shall be fined not less than twenty-five dollars nor more than one hundred dollars, one-half of said fine to be paid to the informer and the residue to the school fund of the county. Penalty.

CASES RELATING TO THE ABOVE SUBJECT MATTER.

Construction of Statutes 1833, Chapter 1833; Chapter 254, 1837; Chapter 310 State *vs.* Mister, 5 Maryland, 11, Constitutionality of Law inflicting penalty of forfeiture.

Smith *vs.* State of Maryland, 18 Howard, 71, Sections 15, 16, 17, 18, Article 71, Code of Public General laws, are not in violation of the Constitution of the State.

Phipps *et al.*, *vs.* State, 22 Maryland, 389.

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REPORT

OF

T. B. FERGUSON,

A

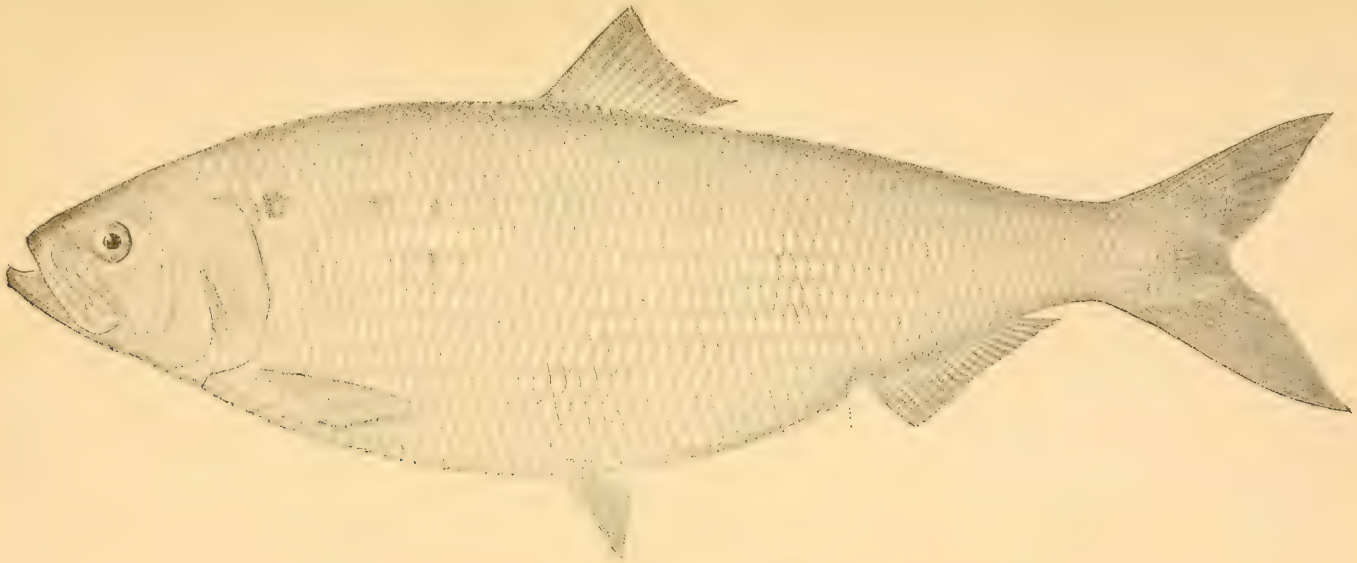
COMMISSIONER OF FISHERIES

OF

MARYLAND.

JANUARY, 1881.

HAGERSTOWN, MD.:
BELL & CO., PRINTERS.
1881.



SHAD, (a little less than ½ natural size) *Alosa sapidissima*, (*female.*)

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REPORT.

...

To his Excellency, WILLIAM T. HAMILTON,

Governor of Maryland.

The following Report contains only an account of the operations of the Maryland Commission so far as conducted under my own supervision. Chapter 150 of the laws of 1874, providing for the appointment of Commissioners of Fisheries, requires "that one of the Commissioners shall come from the Eastern, and one from the Western Shore of the State."

It was agreed, as this law seemed to direct such a course, that the details of the work of the Eastern Shore should be conducted by my colleague, and the work in the western portion of the State should be directed by myself.

To enable us each to carry on the operations in our special sections the appropriation for the year 1880–81 was equally divided between us.

The work of investigation, propagation, distribution, etc., has been conducted on as an extended a scale as the means at my command permitted. The details of these operations, including a distribution of 1,500,000 shad and 690 carp in waters wholly within the eastern section of the State, directly under my supervision, will be found in the following pages.

The young fish deposited at the head of the Bay will be as well for the benefit of the inhabitants of the one shore as for the other, for, on their return from the sea, they are taken by our citizens on either shore in the common waters.

INTRODUCTION.

The year 1880 has been a very important one in the

history of the Maryland Fish Commission, not only on account of the success attained in the attempted propagation of several varieties of valuable fish by artificial means, but because of the accumulated proofs which have been afforded of the success of the effort to fully restock the waters of the State with shad.

In my Report of January, 1880, relating to the operations of the Commission during the year 1879, it was shown that there had been a very marked increase of shad for that year at those points near the head of the Chesapeake Bay and in the Potomac River, where complete records had been kept. During the Spring of 1880, this increase was even more decided, as the catch for that season not only exceeded, very largely, the returns for any one of several previous years; but also, and in a very marked degree, the catch for 1879—the year immediately preceding.

The following figures, compiled by Col. Marshall McDonald, from returns secured from the various sources of information made available by the investigations of the Census Bureau for the Census of 1880, show most clearly the effect which the operations at the head of the Bay, and the large deposit of young shad in the Potomac River, have had upon the yield of those waters, for the catch of shad at the Head of the Bay and in the Susquehanna River from 1870 to 1871 was as follows:

In the year			1870	642,000
"	"	"	1871	720,000
"	"	"	1872	728,000
"	"	"	1873	516,000
"	"	"	1874	583,000
"	"	"	1875	578,000
"	"	"	1876	490,000
"	"	"	1877	464,000
"	"	"	1878	481,000
"	"	"	1879	578,000
"	"	"	1880	614,929
Total—11 years				6,394,929

The average catch for the eleven years, given above, we find to be 581,357; the average catch of the first five years was 637,800, and during the next five years this average was reduced to 518,200. This average, although a decrease from the average of the preceding five years, was considerably increased by the comparatively large catch of the spring of 1879 the first year that the product of artificial propagation was materially felt.

If we eliminate the catch of this year and take the average of the four preceding years—that is 1875, '76, '77 and '78—we have an average yield for those years of 402,600, but the catch of 1880 was 614,929, an increase of 33,572 over the average catch for the whole eleven years, and an increase of 96,729 over the average for the five preceding years, including the year 1879, and 212,329 over the average of the four years immediately preceding the return of the fish produced by artificial means.

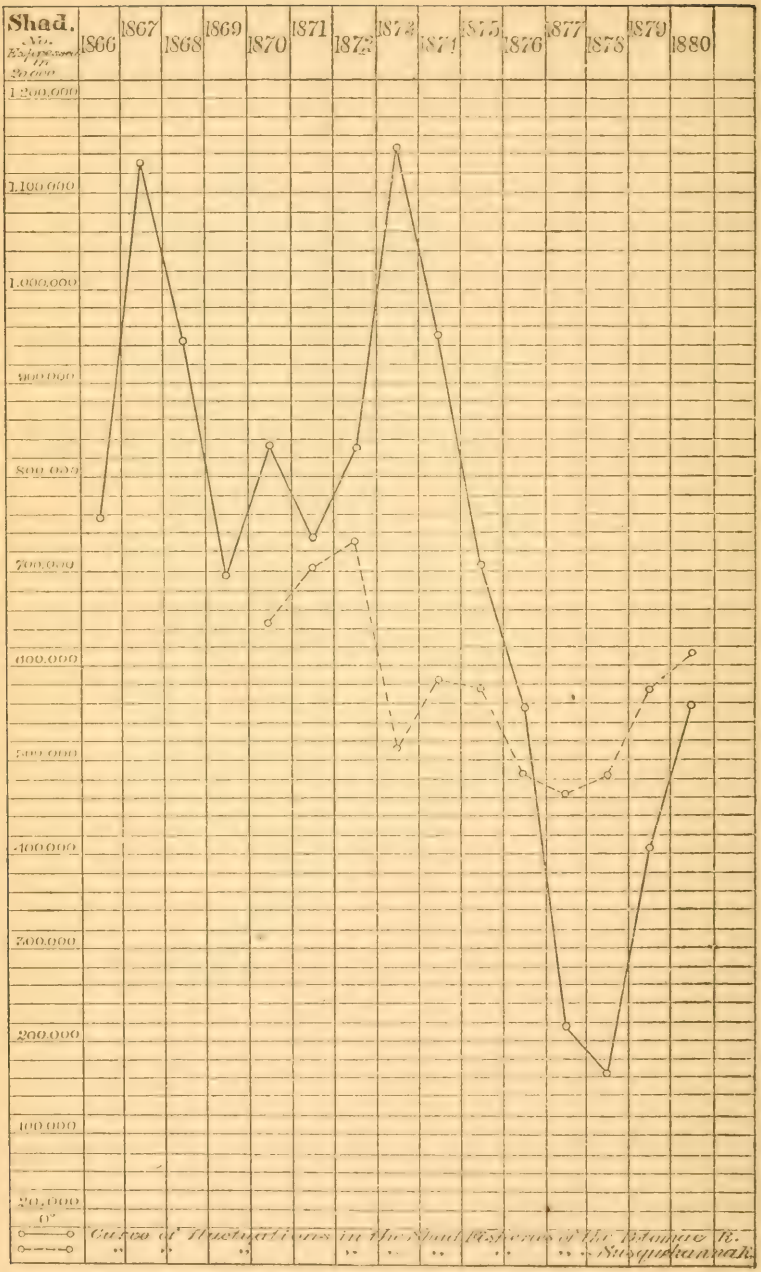
Statement showing amount of fish sold in Washington and Alexandria from 1865 *to* 1880 *inclusive.*

Year.	No. Shad.		
	Alexandria.	Washington.	Total.
1866.	224,096	530,200	754,296
1867.	777,775	350,420	1,128,195
1868.	714,625	230,151	944,776
1869.	417,878	277,125	695,003
1870.	301,137	527,140	828,277
1871.	333,516	401,132	734,648
1872.	367,322	464,136	831,458
1873.	289,729	852,900	1,142,629
1874.	325,340	628,637	953,977
1875.	243,643	464,215	707,858
1876.	237,096	319,079	556,175
1877.	85,562	131,199	216,761
1878.	45,138	121,785	166,923
1879.	77,809	327,537	405,346
1880.	134,081	421,041	555,122
Total—15 years			10,621,444
Average per year for 15 years			708,096
" 66-70—5 yrs.			870,109
" 71-75—5 yrs.			874,114
" 76-80—5 yrs.			380,065

For convenience of reference these statements have been developed in the accompanying diagram. Unfortunately, no reliable records of the fisheries at the head of the Bay and the mouth of the Susquehanna River for the years prior to 1870, could be procured; and, consequently, no such comparative diagram, or statement, of the movement of the fish previous to that time can now be made. Before analyzing the diagram let us glance at the table showing the amount of fish *marketed* in Washington and Alexandria during the last fifteen years:—the records of sales in these two cities indicating, pretty accurately, the yield from the Potomac River, perhaps ten or twenty per cent. of the total amount being taken up by the inhabitants of the adjacent country.

Assuming, then, that the number of fish sold in the two cities named represents the yield of the Potomac, we have a total catch of 10,621,444 shad for the fifteen years from 1866 to 1880; giving an average of 870,109 for the first five years; 874,114 for the next five; and 380,065 for the period from 1876 to 1880; and showing a very remarkable decrease in the yield from this river. The yield for the second five years, that is, from 1871 to 1875, although apparently greater than the average of the previous five years, was, no doubt, the result of more extended fishing; as comparatively few fish were taken in 1866, in consequence of the fisheries not having recovered from the effects of the war, and of the fishermen being without equipment. It will be observed that this decrease would be even more marked but for the catches of 1879 and 1880; as, in the last mentioned year, when the results of artificial propagation began to be realized, we have 555,122—an increase of more than 200,000 over the average yield.

The average of the preceding five years, again, was enlarged by the exceptional yield of 1873; but the large catch of this year was probably owing to the prevalence of easterly winds and other meteorological influences; as


Shad.
No. Exported in 20,000
1,200,000
1,100,000
1,000,000
900,000
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
20,000
0
1866
1867
1868
1869
1870
1871
1872
1873
1874
1875
1876
1877
1878
1879
1880
Curves of Fluctuations in the Shad Fisheries of the Delaware & Susquehanna R.

we find, by turning to the table of the yield on the Susquehanna, that the *minimum* catch for that river occurred the same year. The increase in the Susquehanna for 1880, however, was as marked as that in the Potomac; thereby clearly indicating such increase as being the result of the deposit of the artificially produced fish in both these streams.

The diagram will further show that 1870—the first year in which it is possible to compare the yield of the two localities—was comparatively a *good* year for the Potomac fisheries and a *bad* one for those of the Susquehanna. The next year (1871) showed a decrease in the Potomac, with a corresponding increase in the Susquehanna. The following year—1872—the catch in the Susquehanna increased only 8,000 and that of the Potomac 96,810.

We next find the year 1873 to have been one of great abundance in the Potomac, and of great scarcity in the Susquehanna. In 1874 the Potomac decreased from 1,142,629 to 953,977; while the Susquehanna increased from 516,000 to 583,000.

We recognize in these statements the inevitable result of successive years of over-fishing; of disturbing the fish on their spawning beds; and of preventing them, altogether, from reaching such beds. The diagram indicates a continued, though somewhat irregular, downward tendency in the yield of the Potomac from 1873 to 1878; and of the Susquehanna from 1872 to 1877, the loss in both rivers being finally arrested by the same means.

It will be remembered that the work of shad hatching was commenced in 1875, and was continued the following year—principally at the head of the Bay. In 1876 and 1877 large numbers of young fish were released; and in 1878 a slight increase of shad was observed in the waters of the Bay—a remarkable feature of this increase being the preponderance of small male fish. In 1876 our operations at the head of the Bay were not prosecuted on a

sufficient scale to enable us to transfer many of the young fish to the Potomac; but the numbers deposited in that river were increased from year to year, until, as will be seen by reference to the table of distribution to be found on page 43, 14,350,000 were deposited during last season.

As the Susquehanna region had the advantage of at least a year in the work of artificial propagation, we find that the ascent of the curve appears first upon the chart for that river. In 1878 the yield of the Potomac had reached its lowest figure, 166,923. From this point we have a marked increase in the yield of both rivers, whereas, prior to our efforts to repopulate these streams, there was almost always a decrease in the one whenever any decided increase was observed in the yield of the other.

The increase of the year 1880 was even more marked when we take into consideration certain meteorological influences and their effects upon other localities. It happened that during the early run of the shad in Chesapeake Bay southeasterly gales prevailed which must have driven the fish into Mobjack Bay in large numbers while seeking their native waters of the Potomac and the Susquehanna, since a much larger number were taken at the mouth of the York River and in Mobjack Bay during last season than had been captured the previous year—the catch being increased from 179,374 in 1879, to 239,804 in 1880.

INVESTIGATIONS.

The events of the year 1880 have not only demonstrated beyond question the truth of the theories which have been advanced, and on which the work of the Maryland Commission has been been based; but they have also opened up a new field for the usefulness of this Department; and it is now quite certain that the work of artificial propagation can be extended to those fishes whose habits have hitherto been little known.

The investigations of the last season indicate that the

fishes inhabiting the salt water *exclusively* can be as readily propagated, artificially, and increased to as unlimited an extent as the *anadromous* fishes with whose spawning habits we had been more thoroughly acquainted. The necessity which compelled those fishes—the shad, herring, salmon, etc., which spend most of their lives in the salt water—to enter the rivers for the purpose of spawning enabled us the more readily to study their breeding habits at the time of such annual migration. These varieties, therefore, became the objects of especial care and attention in the infancy of the Commission's existence.

Experiments conducted during last season have demonstrated our ability to hatch and distribute several varieties of fishes, which inhabit our salt water solely, to the same extent as has been accomplished in the case of the shad, and, indeed, it is quite possible that the Bay mackerel may be propagated on a yet larger scale than has been attempted with the shad itself.

About the first of July of last year I received from Messrs. Marshall McDonald and R. E. Earll, who were employed upon that portion of the work of the 10th Census which relates to the fisheries of our coast, an intimation that the Bay mackerel were spawning in Mobjack Bay, and that ripe fish, whose eggs could be readily impregnated by artificial means, were to be had in some numbers from the pound nets operated in that locality. I proceeded to Mobjack Bay, accordingly, in the steamer "Lookout," and succeeded in obtaining a sufficient number of ripe fish of this variety, and also of the porgy, and some other sea-fishes of less importance, to enable me to determine what were the best forms of apparatus to be used in their manipulation. As the immediate object of my investigations was to determine the proper manner in which work should be conducted in the future, rather than to attempt the work itself at

that time, our operations were restricted almost exclusively within experimental limits.

Prof. Baird, U. S. Commissioner of Fish and Fisheries, having kindly sent with me Prof. John A. Ryder, a young naturalist of thorough training and expert in microscopic work, we were able to study the embryology of the mackerel and porgy in a very thorough and satisfactory manner. The result of Prof. Ryder's investigations will be found in a paper prepared by him upon this subject, and which will be published in Prof. Baird's report to Congress.

As the eggs of the mackerel, unlike those of the shad, are somewhat lighter than water and manifest a consequent tendency to float upon the surface, the apparatus used in the cultivation of shad cannot be efficiently employed in their manipulation. It is, therefore, necessary that some other form of apparatus should be devised, as that used in the shad-hatching operations is so constructed that a current of water flows in at the bottom, buoying up the eggs, keeping them constantly in motion, and momentarily bringing fresh particles of water in contact with each egg.

Such a current, either in the conical vessels or in the cylindrical plunge buckets—both of which forms of apparatus have been described in previous reports—acts *against* the gravity of the eggs of the shad; but in the case of those of the mackerel, and of all others that have a tendency to float, the current acts *with* such tendency and causes the eggs to pile in masses at the surface of the water. Several forms of apparatus, in which the direction of the current is reversed, have been experimented with, and are found to act most satisfactorily.

It is hoped that during the next season the work can be conducted at the proper places and on a sufficiently large scale to enable us to determine which form of the vessels that have already been experimented with can be operated with the best results and with the greatest

economy. Ripe mackerel can be found in considerable numbers in the lower part of the Chesapeake Bay, and it may be necessary, in order to conduct the work on a sufficiently large scale, to collect and hatch the eggs outside of the limits of the State, but the young fish can thereafter be very readily transported to the upper portions of the Bay.

The investigations of the past season have developed the fact that a considerable number of ripe mackerel may be secured in the neighborhood of Crisfield, and several fishermen, who have been employed in the capture of this fish, testify that it has not been a great many years since they could be found as far up the Bay as Baltimore, the mouth of the Patapsco River, and elsewhere.

It is certain that the number of this most valuable fish has been very materially diminished in the waters of the State, and that they are becoming more scarce every year. It will, doubtless, require several years to restore them to their former abundance, and to make the catch plentiful enough to furnish a sufficient number of spawning fishes to warrant the establishment of hatching-stations high up the Chesapeake Bay. But as the fish can be very readily transported, the proper mode of proceeding would seem to be to hatch them at favorable places, where they can be had in large numbers, and transfer the young from thence. It is quite likely that they will return periodically to the localities where they were first deposited, for this habit seems to be as strangely characteristic of the coast fishes as of those which inhabit or frequent more inland waters. By way of evidence in support of this expectation, I would refer to the experience of the U. S. Fish Commission in the propagation of cod, in Gloucester Harbor. During the winter of 1878 Prof. Baird established a small experimental station at this point and succeeded in hatching out some millions of young cod. These were liberated in the harbor at Gloucester, and the following summer and fall young

cod, an inch or two in length, were frequently seen in the harbor, none of the fishermen or inhabitants of the town having ever before noticed the young of this fish in those waters. Young fish a year old, and measuring six or seven inches in length, were also taken the next season, and in considerable abundance, in the same neighborhood.

FISH-WAYS.

Having demonstrated the efficiency of the means employed to increase the yield of shad and other migratory fishes, it has now become essential to the thorough success of the work and for the distribution of its benefits to all parts of the State that means be provided for the ascent of these fish to localities from which they are now debarred by natural and artificial obstructions. Although there are no such obstructions in the Susquehanna within the limits of this State, yet the work of restocking the river proper, and of increasing the supply of fish at its mouth would be very materially assisted by opening the river to its sources, as this would not only enlarge the spawning grounds to a proportionate and very considerable extent, but would, at the same time, afford more and better opportunities for the capture of ripe fish.

The construction of proper fishways in the river, in Pennsylvania, and the discontinuance of the use of fish-weirs along the entire length of the river would very quickly yield the best results to the citizens of both States.

The interruption to the progress of fish in most of the rivers of the eastern portion of Maryland consists mainly in the means which are employed for their capture. This matter, however, is within the control of the inhabitants of those sections, to whom I would earnestly recommend the discontinuance of the use of such methods.

Among the principal streams of the Western Shore we

have the Gunpowder River, which is obstructed by a dam of recent construction, a part of the system for supplying the city of Baltimore with water. This and other minor obstructions should be provided with fishways, and if the shad, herring and rock were thus allowed free access to the upper waters of the river, the fisheries below the dam and at the mouth of this stream would soon be vastly improved.

The Patapsco River is also obstructed by many dams, none of which have been provided with effective fishways, although they are especially required by law.

In order to illustrate the practicability of restoring the shad, herring and rock to waters in which they were formerly abundant, but where they have since become unknown, I requested Col. Marshall McDonald, the Commissioner of Fisheries of the State of Virginia, who had made the construction of fishways a specialty, to examine the Patuxent River and advise me as to what could be done on this stream.

If the shad could be brought back in numbers to Laurel, after having disappeared from the river for years, the citizens of Maryland would be satisfied as to the good that would be accomplished by the erection of fishways over all of the artificial obstructions in the State.

That many miles of the Patuxent River, at least, can be opened to the migration of these valuable fishes, will be seen by the following report made as the result of the examinations of that river:

Obstructions to the Ascent of Fish on the Patuxent.

MAJOR T. B. FERGUSON,

Commissioner of Fisheries for Maryland.

DEAR SIR:—Maj. O. C. Henderson, whom I sent to ascertain the number and character of the obstructions to the ascent of fish on the Patuxent, reports as follows:

The first dam is at Jericho Mills, about three hundred

yards below R. R. Bridge (B. & P. Railroad), about one and one-half miles from Bowie.

The dam is built of brush and stone, and the difference of water level, above and below the dam, is 3 feet.

At low stages of water none passes over the dam. Ordinarily, in April, May and June surplus water passes over the dam in sufficient quantity to feed a fish-way without interfering with mill supply.

At the present time no shad or rock ascend to this point, and rarely a herring. This is due to the complete obstruction of the river by nets and weirs below.

The 2nd obstruction reported by Major Henderson, is the dam of the Iron Works Mills, four miles below Laurel and one and one-half miles from Contee station, Washington branch B. & O. R. R. The difference of water level at this dam is only about 2 feet.

At Avondale Mills, about one and one-half miles below Laurel, is a stone dam about five feet high, which is the third and last obstruction on the river until you ascend to the dam of the Laurel Cotton Mills.

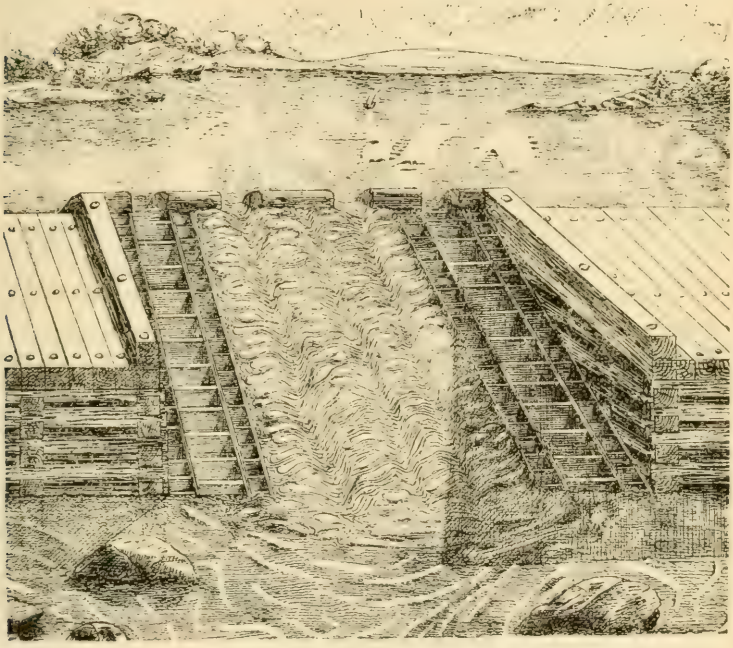
The dam of the Laurel Mills is built of stone, and is about 28 feet high. At ordinary summer stages of water, there is no discharge of water over the dam. The whole stream is diverted to furnish motive power to the cotton mills, and at very low stages of water this is supplemented by steam power.

The river may be opened to the Laurel Mills so as to permit free passage of fish with comparatively little trouble and at a very moderate expense.

Below this point the supply of water is considerably in excess of the amount used for motive power, and a sufficient quantity of water may be discharged through the fishways to invite the ascent of shad, which are a timorous fish, and indisposed to enter a way discharging an inconsiderable volume of water.

The general plan of fishway I would recommend for the three lower dams of the Patuxent is represented in

the accompanying cut, which represents a fishway discharging a volume of water from 12 to 15 inches deep and ten feet wide.



McDONALD FISHWAY.

Showing working at low water stage.

For economy of water supply at low stages of water, the middle section five feet in width is depressed below the plane of the sides, so that only this middle section takes water when the river is low. In full stages of water the whole breadth of the fishway discharges.

Fishways should always, when practicable, be recessed into the dam, so that the discharge from the lower end of the fishway will be on a line with the lower face of the dam. Where not practicable to recess the fishway as indicated, then it should be placed next to the bank and a sloping apron placed in the angle between the fishway and the dam, so as to establish an uninterrupted line of overfall from the mouth of the fishway to the dam. This

construction will in the case of low dams practically place the mouth of the fishway in the line of the face of the dam.

In the case of high dams it will probably be better to build the fishway with a return or elbow, so as to make the discharge at the face of the dam.

In the case of the Laurel Mills dam, there being no surplus of water to deal with ordinarily, the fishway may be made much narrower and the water discharge proportionally reduced; a width of two or four feet for the water way would in this case be enough. Such a fishway would provide access to the upper waters of the Patuxent for the salmon, the herrings and all the anadromous or river species, except the shad. I doubt if the volume of water would be sufficient to induce the ascent of the last named species in considerable numbers.

I also examined the dam at the Relay House, on the Patapsco. This is a timber dam about 7 feet high, and is the first obstruction on the river above tide-water. Upon the dam there is now a crude fishway of the old style, built by the owner, I presume, in conformity to the requirements of the State law.

It is not probable that the State will enter upon the enforcement of a law making the erection of fishways obligatory, until their efficiency has been tested and approved by your State Commission.

The dam above mentioned furnishes an admirable location for making the experimental tests required.

I have therefore carefully examined the locality, and submit to you the general plan of a fishway, such as I think well adapted to meet the particular requirements of the case, and if approved, will serve as a model for subsequent constructions.

The cost of this construction will be from five to eight hundred dollars, varying with the cost of securing the foundations on which to build the superstructure.

Very respectfully yours,

M. McDONALD.

SHAD—*Alosa sapidissima.*

The co-operation of the U. S. Fish Commission, during previous years, having proved so important in general results and so advantageous to the State of Maryland, I naturally sought a continuance of such co-operation and assistance in arranging for our spring work.

I was most fortunate in securing the detail of two machinery Barges, together with two others, which had been furnished with quarters for the employes, for the station at the Head of the Bay, to which they were transferred in the latter part of April.

Prof. Baird had obtained from the Secretary of the Navy the loan of two steam launches which could be readily used in collecting the eggs of the Shad, both from the large fisheries and from the gillers operating in the neighborhood of Havre de Grace. I, therefore, determined to utilize the Steamer "Lookout" on the Potomac River. As she was provided with hatching apparatus sufficient to accommodate from 600,000 to 1,000,000 eggs, we confidently expected to hatch out several million eggs during the fishing season on this river.

POTOMAC RIVER.

During an inspection of the fisheries on the Potomac River, on the 26th of April, I chanced to arrive at Mr. Skidmore's fishery, at Moxley's Point, about 6 o'clock in the afternoon, as the seine was being landed, and found unexpectedly, a considerable number of ripe male and female shad.

About a quarter of a million of eggs in good condition were readily secured, but as it was considerably earlier in the season than we had ever before obtained ripe shad on this river, the hatching appartus had not yet been placed in running order, and, after keeping the eggs a few hours in pails, I emptied them into the Eastern Branch of the river at a point near the Navy Yard.

Finding the season so unusually advanced I immedi-

ately secured the equipment of the Steamer for the spring work and commenced active operations on the 4th day of May. About 650,000 eggs were secured at Moxley's Point on the same night, and as this number completely filled the apparatus on the Steamer, the work of taking eggs was necessarily discontinued until additional apparatus could be improvised for their reception.

This success on the Potomac, it should be remembered, was wholly without precedent and as we had provided means only for hatching eggs in such numbers as we had hitherto been able to secure, we were totally unprepared to handle the quantities which were obtainable at this period.

In this state of affairs I again looked to Prof. Baird for assistance, and through his influence secured from the Navy Department permission to use the hydrant water in the Navy Yard at Washington, and also to put up apparatus for developing the eggs which might be gathered by the "Lookout."

The assistance which was obtained from the Machine Shops at the yard enabled us, in a few days, to have a dozen cones running, which was as many as I thought it necessary to provide, for with these we were prepared to take care of from twelve to eighteen hundred thousand eggs, and I did not hope to have more than this number on hand at one time. It must be borne in mind that it only required about three days from the time that the eggs were taken for their full development, when they could either be deposited in local waters or transferred to other points, leaving the vessels free to receive fresh supplies. As the "Lookout," however, gathered from one to two million eggs a night during this period, the apparatus which was erected was taxed to its utmost capacity, and additional cones were added as fast as they could be manufactured until, finally, their number reached forty six exclusive of the half dozen on the bow of the "Look out," which were used as receptacles for the eggs as they

were gathered, and for their transfer from the points below Alexandria to the Navy Yard. All of these vessels were simultaneously employed upon several occasions during this short season—some times turning out as many as 2,000,000 young fish in a day.

The details of these operations may be found in the accompanying tables from which it will be seen that nearly 19,000,000 fish were produced at this somewhat impromptu establishment. Of this number over 14,000,000 were deposited in the waters of Maryland. The record of this distribution will be found on page 43, combined with that of the fish produced at Havre de Grace.

If this extraordinary success could have been anticipated, and sufficient apparatus in working order had been provided from the commencement of the season, I am quite confident that the total result above given would have been increased to over 30,000,000. But when the records of the hatching operations on the Potomac River for 1880 are compared with those of other years, as given in previous reports, it will be seen that the organization of the work on such a scale would have appeared wholly unnecessary.

The Steamer "Lookout" continued her nightly trips down the river with varying success until the end of June.

As the law prohibiting the catching of fish after the 1st of June is utterly ignored on the Potomac, outside of the District of Columbia, I determined to gather all the spawn that could be obtained from the fish taken, and from them producing as many young fish as possible in order to keep up the future supply in this river. The experiences of this year on the Potomac are most important, not only on account of the magnitude of the work and of the results accomplished, but as affording a clear indication of the good results of our former efforts and as demonstrating how readily and successfully the work

can be conducted in the future, so long as we can secure the valuable co-operation of the U. S. Government.

It is quite possible that the period of the runs of Shad in the rivers has a close relation to the time in which the young fish are originally hatched, and the early run may possibly be the result of the fish which are first hatched in any given season.

The disturbance of the fish for many years by seines and gill-nets has interfered materially with the production of young from the earliest spawners, and from this cause the early runs were gradually becoming exhausted. It is possible that as by artificial propagation we have been able to deposit young fish, produced from spawn taken from the early runs, the earlier schools have been increased, and we are not now dependent solely for the supply of the future upon the limited number of fish produced by the late runs, which spawn after the season is so far advanced that most of the seines and gill-nets have ceased their operations.

U. S. AND MD. COMMISSION OF FISH AND FISHERIES.

RECORD OF TEMPERATURE OBSERVATIONS made at Washington, on the Steamer Lookout, from May 4th, 1880, to June 18th, 1880, by W. P. Sauerhoff and Wm. Hamlen.

Date.		Temperature of—									Depth of Water at Station.	Wind.						Condition of—				State of—			
Day of Week.	Day of Month.	Air.	Surface Water.	Bottom.	Air.	Surface Water.	Bottom.	Air.	Surface Water.	Bottom.		Direction.	Intensity.	Direction.	Intensity.	Direction.	Intensity.	Sky.	Sky.	Sky.	Water.	Tide.	Tide.	Tide.	
		6 a.m.			12 m.			6 p. m.				6 a. m.		12 m.		6 p. m.		6 a. m.	12 m.	6 p. m.		6 a. m.	12 m.	6 p. m.	
Tuesday	4							76	68	67	20 feet.	S. E.	Light	S. E.	Light	S. E.	Light	Clear	Clear	Clear	Muddy		Flood	Ebb	*a*
Wednesday	5	67	67	66	82	72	70	78	69	68	"	E.	"	E.	"	E.	"	"	"	"	"	Flood	Slack	"	
Thursday	6	68	67	66	84	73	66	81	71	70	"	W.	"	W.	"	N. W.	"	"	"	"	"	"	"	"	
Friday	7	65	67	66	80	71	70	78	72	70	"	S. W.	"	E.	"	S. E.	"	Cloudy	"	"	"	"	Ebb	Flood	*b*
Saturday	8	61	68	66	85	73	71	81	72	70	"	N. E.	"	N.	"	N. E.	"	"	"	Cloudy	"	"	"	"	
Sunday	9	72	70	67	90	74	72	85	76	75	"	S.	"	S.	Fresh	S.	"	Clear	"	Clear	"	"	Flood	Ebb	*c*
Monday	10	72	71	70	91	76	75	83	75	74	"	S.	"	S.	"	S.	Strong	"	"	"	"	"	Ebb	Flood	*d*
Tuesday	11	71	73	72	82	76	75	61	74	73	"	S. E.	"	N.	Light	N. W.	Fresh	"	"	Cloudy	"	"	"	"	*e*
Wednesday	12	62	71	70	75	74	73	71	73	72	"	W.	"	N. W.	"	N. W.	"	"	"	Clear	"	"	"	"	*f*
Thursday	13	61	70	70	73	73	73	60	72	72	"	W.	"	N.	Fresh	N. E.	Light	"	"	Cloudy	"	"	"	"	*g*
Friday	14	57	70	70	67	70	70	65	69	69	"	N. W.	Fresh	N. W.	"	N.	"	"	"	Clear	"	"	"	Slack	*h*
Saturday	15	52	65	65	70	71	71	67	71	71	"	N. E.	Light	N. W.	"	N. W.	"	"	"	"	"	"	"	Ebb	*i*
Sunday	16	68	67	67	84	72	71	81	72	71	"	S. W.	"	S. W.	Light	S. W.	"	"	"	"	Clear	Ebb	Flood	"	*j*
Monday	17	71	70	70	90	72	71	83	73	72	"	W.	"	W.	"	W.	"	"	"	"	Muddy	"	"	"	*k*
Tuesday	18	69	70	70	86	74	73	83	75	74	"	N. W.	"	N. W.	"	S. W.	"	"	"	"	"	"	"	"	*l*
Wednesday	19	66	73	72	88	75	74	81	76	75	"	N. E.	"	N. E.	"	N. E.	"	Cloudy	"	"	"	"	"	"	*m*
Thursday	20	78	75	74	87	76	75	87	76	75	"	S. W.	"	S. W.	Fresh	S. W.	Fresh	Clear	"	"	"	"	"	"	*n*
Friday	21	71	74	74	88	77	76	86	76	75	"	S.	"	S. W.	Strong	S. E.	Strong	"	Cloudy	"	"	"	"	"	*o*
Saturday	22	71	74	75	73	75	75	70	75	75	"	S. E.	"	S. E.	Light	N. W.	Light	Cloudy	"	Cloudy	"	"	"	"	*p*
Sunday	23	70	74	75	68	74	75	67	74	75	"	N. E.	"	N. E.	"	N. E.	"	"	"	"	"	Flood	Ebb	"	*q*
Monday	24	71	75	75	88	75	75	85	75	75	"	N. E.	Calm	S.	"	S. W.	"	"	Clear	Clear	"	"	"	Flood	*r*
Tuesday	25	80	76	76	85	76	76	88	77	76	"	S.	Light	S.	"	S.	"	Clear	"	"	"	"	"	"	*s*
Wednesday	26	75	77	77	87	79	78	89	77	66	"	S.	"	S. W.	"	S.	"	"	Cloudy	Cloudy	"	"	"	"	*t*
Thursday	27	72	79	78	89	82	81	89	79	78	"	S.	"	S. W.	"	S. W.	"	"	"	Clear	"	"	"	"	*u*
Friday	28	75	78	78	85	80	80	78	79	78	"	S.	"	S. W.	Fresh	W.	Strong	"	"	Cloudy	Clear	"	"	"	*v*
Saturday	29	75	79	78	75	80	80	74	78	78	"	N. E.	"	N. E.	Light	N. E.	Light	"	Clear	"	Muddy	Ebb	Flood	Ebb	*w*
Sunday	30	73	78	78	74	77	77	73	77	78	"	S. E.	"	N. E.	Fresh	S. E.	Fresh	Cloudy	Cloudy	"	"	"	"	"	*x*
Monday	31	72	77	77	78	77	77	83	78	78	"	N. W.	Fresh	N. W.	"	N. W.	Light	Clear	Clear	Clear	Clear	"	"	"	*y*
Tuesday	1	75	77	77	94	78	78	85	78	78	"	S. W.	Light	S. W.	Light	S. W.	"	"	"	Cloudy	Muddy	"	"	"	*z*
Wednesday	2	60	73	73	68	73	73	62	73	73	"	N. W.	Fresh	N. W.	Fresh	N. W.	"	Cloudy	Cloudy	"	"	"	"	"	*a*
Thursday	3	60	75	74	78	77	77	80	77	77	"	N. W.	Light	N. W.	Light	S.	"	Clear	Clear	Clear	"	"	"	"	*b*
Friday	4	62	75	74	87	76	76	84	77	77	"	N. W.	"	S. W.	"	S. W.	"	"	"	"	"	"	"	"	
Saturday	5	70	74	75	79	76	75	80	77	76	"	S. W.	"	S.	"	S.	Fresh	Cloudy	"	Cloudy	Clear	"	"	"	
Sunday	6	69	75	74	78	76	75	77	76	75	"	S.	"	S.	"	S.	Light	Clear	"	"	"	Slack	Ebb	Flood	
Monday	7	76	74	74	88	79	78	83	76	75	"	S.	"	W.	Light	S.	Calm	"	"	"	Clear	Flood	"	"	
Tuesday	8	73	74	74	83	79	76	86	79	77	"	N. W.	"	N. W.	"	N. W.	Light	"	"	"	Cloudy	"	"	"	
Wednesday	9	70	75	74	78	75	75	76	75	75	"	N. E.	"	N. E.	"	N. E.	"	Cloudy	Cloudy	"	"	"	"	"	
Thursday	10	68	75	75	72	75	75	74	75	75	"	S. E.	"	S. E.	"	S.	"	"	"	Clear	"	"	"	"	*c*
Friday	11	74	74	74	88	77	77	87	79	78	"		Calm	S.	"	S. E.	"	Clear	Cloudy	"	"	"	"	"	
Saturday	12	76	77	77	94	79	78	79	79	78	"	S.	Light	N. W.	"	W.	"	"	Clear	"	"	"	"	"	*d*
Sunday	13	80	78	77	95	79	78	90	82	81	"	N. W.	"	N. W.	Fresh	N. E.	"	"	"	"	Muddy	"	"	"	
Monday	14	77	78	78	85	79	78	83	78	78	"	N. W.	"	N.	Light	N. E.	"	Cloudy	Cloudy	"	"	Ebb	Flood	Ebb	*e*
Tuesday	15	67	78	78	66	77	77	65	76	77	"	N. E.	"	N. E.	Fresh		Calm	"	"	"	"	"	"	"	*f*
Wednesday	16	65	76	76	74	77	77	75	77	77	"	N. E.	"	N. E.	Light	N. W.	Light	Clear	"	"	"	"	"	"	*g*
Thursday	17	70	75	76	85	77	77	84	78	78	"	N. W.	"	N. W.	"	S.	"	"	Clear	"	"	"	"	"	*h*
Friday	18	68	75	75	86	77	77	85	79	78	"	S.	"	S.	"										*i*

a. Left Navy Yard 12.45 p. m. Returned at 9.50 p. m. 650,000 eggs.
b. Thermometer 98° at 2.30 p. m.
c. Left Navy Yard 5.40 p. m.
d. Returned to Navy Yard 1.20 p. m.
e. Left Navy Yard 4.15 p. m. Returned 11.10 p. m.
f. Left Navy Yard 12.50 p. m. Rain 5.30 p. m. Stopped 7 p. m.
g. Returned to Navy Yard 8.53 a. m. Left Navy Yard 3 p. m.
h. Returned Navy Yard 9.25 a. m. Left " " 4 p. m.
i. Returned to Navy Yard 11.35 a. m.
j. Left Navy Yard 1.35 p. m. Returned 10.30 p. m.
k. Remained at Navy Yard. Left Navy Yard 1.22 p. m.
l. Returned 12.30 p. m.
m. Left Navy Yard 5.40 p. m. Returned 11.15 p. m.
n. Remained at the Navy Yard.
o. Left Navy Yard 3.27 p. m.
p. Returned to Navy Yard 9.05 a. m. Left Navy Yard 4.10 p. m.
q. Returned to Navy Yard 7.20 a. m. Left Navy Yard 5.30 p. m.
r. Returned Navy Yard 9.10 a. m.
s. Returned Navy Yard 8.05 a. m. Left Navy Yard 6.15 p. m.
t. Returned Navy Yard 6.25 a. m. Left " " 6.30 p. m.
u. Returned Navy Yard 6.45 a. m. Left " " 8.17 p. m;
v. Returned to Navy Yard 7 a. m. Left " " 12.50 p. m.
w. Returned to Navy Yard 7.15 a. m. Left " " 3 p. m.
Returned Navy Yard 9.05 p. m. Rain.
x. Left Navy Yard 3.20 p. m. Returned Navy Yard 9.40 p. m. Rain.
y. Left Navy Yard 4 p. m. Ret. " " 10.10 p. m.
z. Left Navy Yard 6.30 p. m. Ret. " " 12.25 p. m.
a. Left Navy Yard 5 p. m.
b. Stationed at Ft. Washington.
c. Rain 6.30. Stopped 11 a. m.
d. Rain storm 3 p. m. Stopped 4.30 a. m.
e. Rain 9.30 p. m.
f. Rain.
g. Rain stopped 7.30 a. m.
h. Strong current with the ebb tide. Water very muddy at 7 p. m.
i. Water very muddy.

RECORD OF SHAD HATCHING OPERATIONS conducted at Washington, D. C., on the Str. Lookout and wharf at Navy Yard, from Tuesday, May 4th, 1880, to Sunday, June 27th, 1880, by Messrs. Sauerhoff, Hamlen and Clark.

Date.			Sources Whence Fish were Obt'ed.		Fish Taken by—					Ripe Fish					
					haul-seines.				gill-nets						
Day Week.	Day of Month.		Total length of haul-seines visited. Fathoms.	Total length of gill-nets visited. Fathoms.	No. Shad.	No. Herring.	Lbs. of Rock.	Other Fish.	No. Shad	Males.	Females.	Eggs Obtained.	Fish Hatched.	Fish Deposited in Local Waters.	Fish Deposited in Other Waters.	
Tuesday	May	4	300		400	700		400		39	35	650,000				*a.*
Wednesday		5														*b.*
Thursday		6														*c.*
Friday		7														*d.*
Saturday		8	300			75,000		500					635,000	635,000		
Sunday		9	300		103	30,000		300		17	16	320,000	310,000	50,000		*e.*
Monday		10														*f.*
Tuesday		11			227	20,000	15	1,000	320	23	19	380,000	360,000	310,000		*g.*
Wednesday		12				17,000	25	450	430	27	25	500,000	470,000			*h.*
Thursday		13	200		166	23,000	18	200	179	67	50	1,000,000	850,000			
Friday		14														*i.*
Saturday		15			376	3,000	30	75	135	47	38		725,000	360,000		*j.*
Sunday		16										760,000		320,000		

a. Eggs obtained at Moxley's Pt., Capt. Skidmore.
b. Remained at Navy Yard. Cones overcrowded.
c. Remained at Navy Yard.
d. Fish hatching out.
e. Obtained 1,220,000 herring eggs at Moxley's Point; Lost 120,000 herring eggs at Moxley's Point.
f. Seines not hauling on account of tide.
g. 320 eggs from gill-nets; 60,000 eggs from haul-seines; 300,000 herring deposited in the Potomac.
h. Obtained 180,000 herring eggs at stake net.
i. Remained at Navy Yard.
j. 180,000 herring deposited at Cumberland, Md.

RECORD OF SHAD HATCHING OPERATIONS conducted at Washington, D. C., on the Str. Lookout and wharf at Navy Yard, from Tuesday, May 4th, 1880, to Sunday, June 27th, 1880, by Messrs. Sauerhoff, Hamlen and Clark. Cont'd.

Date.			Sources Whence Fish were Obt'ed.		Fish Taken By—					Ripe Fish		Eggs Obtained.	Fish Hatched.	Fish Deposited in Local Waters.	Fish Deposited in Other Waters
					Haul-seines.				Gill-nets						
Day Week.	Day of Month.		Total length of haul-seines visited. Fathoms.	Total length of gill-nets visited. Fathoms.	No. Shad.	No. Herring	Lbs. of Rock.	Other Fish.	No. Shad	Males.	Females.				
Monday	May	17	537			1,500	17	125	425	115	104	2,070,000	2,036,000	400,000	
Tuesday		18			979	400	25	150	150	63	57	1,114,000	1,084,000	200,000	
Wednesday		19													160000*a*
Thursday		20				100	37	200	73	87	76	1,520,000	1,300,000	400,000	
Friday		21	300		735	250	75	200	325	130	119	2,320,000	2,000,000	800,000	
Saturday		22	300		650	400	25	150	197	70	55	1,100,000	1,000,000	825,000	
Sunday		23	300		475	250	20	400	250	29	26	520,000	450,000		2000000
Monday		24	300		560	100	15	600		25	20	400,000	350,000	800,000	
Tuesday		25	300		327	150	8	700	297	19	15	300,000	250,000	1,400,000	
Wednesday		26	300		36	25	30	400	97	2	2	30,000		2,400,000	*b*
Thursday		27	300		187	125	60	125	129	2	2	40,000		150,000	
Friday		28	300		199	200	40	50	179	15	14	280,000	230,000	150,000	200000
Saturday		29		400					325	21	18	525,000	275,000	250,000	
Sunday		30		525					393	22	38	760,000	675,000		
Monday		31		575					257	39	53	1,040,000	900,000		
Tuesday	June	1		425					127	19	23	430,000	300,000	30,000	200000
Wednesday		2		380					251	46	50	840,000	700,000	275,000	
Thursday		3		575					249	23	23	410,000	375,000		
Friday		4		500					157	23	25	450,000	400,000	675,000	

a. Remained at Navy Yard. Cones overcrowded.

b. Eggs of the 26th and 27th were so poor that none were hatched.

Saturday	June 5		275				37	5	5	95,000	90,000	900,000		*a*
Sunday	6											300,000	700000	*b*
Monday	7		450				202	32	37	650,000	615,000	375,000		
Tuesday	8		775				254	37	39	670,000	600,000	400,000		
Wednesday	9		725				114	18	24	400,000	375,000	100,000		*c*
Thursday	10		500				157	5	6	100,000	85,000			
Friday	11												300000	*d*
Saturday	12											575,000	240000	*d*
Sunday	13											475,000		*c*
Monday	14		375				205	29	31	520,000	450,000	*85,000		
Tuesday	15		175				72	9	10	140,000	100,000			
Wednesday	16		250				276	20	24	315,000	300,000			
Thursday	17		275				108	11	10	180,000	160,000			
Friday	18											*50,000	400000	*f*
Saturday	19											*100,000		*g*
Monday	21									20,000	15,000			*h*
Tuesday	22									120,000	85,000	*160,000		
Sunday	27											*100,000		
		4037	7180	5420	172,200	440	6025	6370	1136	1089	20,749,000	18,550,000	14,350,000	4200000

a. Eggs placed in hatching boxes at Ft. Washington.
b. No boats gilling.
c. 100,000 shad placed in the Potomac at Ft. Washington.
d. Str. remained at Navy Yard. Str. remained at Navy Yard.
d. " " " "
e. 175,000 shad used for experimental purposes.
* 85,000 " " " " "
f. Steamer remained at Navy Yard.
* 50,000 shad used for experimental purposes.
g. Steamer remained at Navy Yard.
* 100,000 shad used for experimental purposes.
h. Steamer remained at Navy Yard on 20th.
* 160,000 shad used for experimental purposes.
* 100,000 shad used for experimental purposes.

HAVRE DE GRACE STATION.

This station was placed under the immediate charge of Mr. John S. Saunders of Baltimore, who had obtained considerable experience in shad work during his employment by the U. S. Commission in North Carolina, in the seasons of 1878-9.

The barges, to which reference has hitherto been made, having been remodled and placed in thorough order during the time they were laid up at Baltimore, I directed that they should be transferred to Spesutie Narrows, a convenient and central locality, from which the large fisheries and the gillers could readily be reached. The entrance to this harbor had been dredged by the Engineer Department, to allow safe passage for the steam launches. During the early portion of the season, while the haul seines were being operated on Spesutie Island and on the Floating Batteries adjacent, these fisheries were visited daily and eggs obtained from them, as well as from the gill-nets which were drifted on the flats.

An extended drought, with a prevalence of south-easterly winds, caused the salt water to back up the bay, and the water became so brackish in Spesutie Narrows as to endanger the eggs. It was, therefore, found necessary on the 30th day of May to remove the barges from this locality to a point above Havre de Grace, between Watson's Island and the Cecil County shore. This change of location in the midst of the season no doubt contributed materially towards lessening the results obtained at this station.

Particulars of the work conducted under the supervision of Mr. Saunders will be found in his report and journal which are herewith submitted.

MARYLAND COMMISSION FISH AND FISHERIES,

BALTIMORE, Md., Sept. 25th, 1880.

MAJ. T. B. FERGUSON,

My Dear Sir: - Please find herewith enclosed a rough journal of operations at Havre de Grace during the months of May and June. In forwarding the same, I would make a few suggestions in regard to some changes which I think would be beneficial. There should be some cover or awning made to protect the cylinders in case of rain, as the drops kill the eggs and young fish, and we found it impossible to cover them with tops, the rain coming on us so rapidly. A folding awning could be easily arranged to drop in a few minutes.

There should also be a hinged plank placed on the sides of the barge to enable the men to walk around the outside of it in order to examine the cylinders, place eggs in them and remove young fish, as we found it extremely difficult to do so from boats. This arrangement could be made at slight cost, and would not be at all unsightly. I consider the working of the cylinders as now arranged a great success, and after a careful examination think the results are fully a third more, in hatching, than are obtained in cones; the economy of labor and attention being very much in favor of the cylinders. There should be some improvement made in fastening wire bottoms to cylinders, since as they are now made, they break at the outer band and lose a great many young fish. I would also advise a net being placed under them to prevent eels &c., from sucking the eggs through the bottoms. I would also suggest, for future service, that a better class of engineers be employed, as a great responsibility is placed upon them, and they should be both careful and competent to repair any breaks &c., in the machinery. Six or eight first-class, reliable men would do more, I think, in getting spawn &c., than a larger number; for it was my misfortune this season to be

troubled with quite a number, when the same results, and perhaps better, could have been accomplished with half the number of reliable men.

Very respectfully yours,
JNO. S. SAUNDERS.

April 29.—Cast off from City yard, South Baltimore, with three (3) barges in tow of tug boat "Mohawk" at 10.15 A. M., cast off from tug "Mohawk" at 11 A. M.; off Fells Point, and was taken in tow by U. S. Revenue Cutter "Ewing" to be carried to Spesutie Narrows, head of Chesapeake Bay. Had heavy wind from S. E. with rain all day. Arrived off Narrows at 5.00 P. M. Dropped anchor at 5.20 P. M. at Narrows where we remained all night on account of heavy wind and rain. Steamer returned to Baltimore after seeing us safely anchored.

April 30.—Wind changed to N. W. about 1 A. M. with heavy rain. Wind increasing until about 4 A. M. when it was blowing a gale. Had to let go all anchors, as also anchor Machinery barge by itself and Steam launch. Wind blowing a gale all day.

May 1.—Wind calmed down about 4 A. M. when all hands were called. Weighed anchors and succeeded in getting barges safely moved in Narrows about 12 M. Left in Launch at 1 P. M. for Havre de Grace, where I telegraphed arrival &c., to Maj. Ferguson. Returned to Narrows about 4 A. M. Wind N. W.

May 2.—Clear and pleasant. Had men cleaning up and regulating cones. Gave the steam launch a coat of paint. Wind S. E.

May 3.—Clear and pleasant. Discharged colored cook on account of negligence and drunkeness. Placed Freedy in charge of kitchen. Sent men to gather spawn; they returned about 11 P.

M. bringing about 40,000 eggs. The eggs were very indifferent. Frank Farr reported for duty as pilot for Launch and brought colored boy to do temporary cooking. Wind S. W.

May 4.—Clear and warmer. Sent men out to the Batteries. They returned with about 275,000 eggs. Machinist Flynn and Fireman Slavin reported for duty. Wind gentle from S. W.

May 5.—Clear and pleasant. Reported result of taking eggs to Maj. Ferguson. Men went to Batteries, returned with about 150,000 eggs. Frank Courtney reported for duty. Wind during day N. E., E. and S. E. Received word that Maj. Ferguson would be down.

May 6.—Clear and pleasant. Sent Launch to Havre de Grace for Maj. Ferguson, leaving men at Batteries on way up. Maj. Ferguson arrived about 1 P. M. bringing Mr. Davenport and colored cook M. Robinson. Maj. Ferguson returned about 4. P. M. Launch returned about 9 P. M. bringing men from Batteries. They obtained 475,000. M. Gleason reported for duty and was assigned to care of cones and hatching. Wind variable N. to. W.

May 7.—Clear and pleasant. Sent Launch to Harve de Grace for mail, leaving men at Batteries on way up. They returned about 8 P. M. bringing about 400,000 eggs. Turned much colder after sundown with heavy wind from S. E. First eggs hatched. Eggs not doing well on account of being badly impregnated, as also stoppage of water by foul pipes. Mr. Davenport accompanying men at night.

May 8.—Cloudy and overcast. Cleared away about 11 A. M. Left for Baltimore at 9.52 and returned at 4 P. M. Accompanied men at night in getting eggs and returned at 11 P. M. with

550,000. Great scarcity of ripe male fish, causing bad impregnation of eggs. Had inventory of scow taken. Colored boy (acting as cook) left.

May 9. Clear and warm. Sent men to Batteries, gillers not being able to cast on account of heavy wind. They returned with about 250,000 eggs. Wind S., S. W.

May 10.—Clear with wind strong from S. W. Eggs hatching out rapidly. No instructions as to distribution of fish. Received box containing the following articles: Small wrench, tallow pot, two ½ inch round files, piece of packing and boat hook. Men returned about 9. P. M. with about 250,000 eggs. Wind strong from S. W.

May 11.—Clear and pleasant. Received orders to turn out all young fish in river above Havre de Grace. Turned out at 5 P. M. above Havre de Grace 150,000 fish, and about 250,000 off Narrows, not having cans with which to transport them above Havre de Grace. Sent Mr. Davenport to Washington as ordered. Received bundle containing pillows. Visited Batteries. Large catch of shad (new run) but none ripe. Obtained about 180,000 eggs from gillers. Great quantities of perch taken in haul seines. Attempted to get eggs but was unsuccessful.

May 12.—Clear and pleasant. Wind strong during day from N. W. Sent 145,000 young fish above Havre de Grace, and also turned out 100,000 off Narrows. Launch returned bringing Mr. Davenport and colored boy, S. Robinson, also 11 U. S. cans, one bucket, one dipper, two tin syphons and two pieces hose. Men went out about 6 P. M. returning about 11 P. M. with 250,000.

May 13.—Clear. Wind heavy from N. W. Sent 300,000 young fish to be placed in river above Havre de Grace, at 9 A. M. Launch returned at 12 M., bringing bbl. containing lanterns and a package from Register & Sons. Permitted A. Hamlen to go to Baltimore to see his brother, who had been seriously injured by an explosion of old shells. Turned out 250,000 young fish in narrows, at 5 P. M. Obtained 200,000 eggs at night, and would probably have gotten more had it not been for heavy wind, which prevented gillers from going out.

May 14.—Clear and cold. Heavy wind from N. E. Sent 270,000 young fish above Havre de Grace at 9 A. M. Mr. J. A. Ryder returned in launch. Wind moderate at night and men went out, obtaining 300,000 eggs. Arranged a laboratory for Prof. Ryder. Mr. Heywood reported for duty.

May 15.—Clear and cold. Sent 215,000 young fish above Havre de Grace. Received by mail a draft for $100.00 for incidental expenses. Sent Mr. Davenport and Mr. Simmons to Washington, as ordered. Men went out at 6 P. M. and returned with 750,000 eggs. Large number of female fish found, but very few males.

May 16.—Clear and pleasant. Had a great many visitors during the day. Sent men out at night and they returned with 275,000 eggs. Small launch arrived from Washington about 11 P. M., in charge of Capt. I. Poplein, who reported as having been detained by heavy winds.

May 17.—Clear and warm. Prof. Ryder went up to Batteries to examine spawn of perch, &c.

Was unsuccessful in getting any, but brought specimen of cat-fish caught at Osborne's battery. The Agent of the Pennsylvania Fish Commission arrived about 3 P. M. for young fish. Delivered to him 200,000 which we sent in steam launch to Pt. Deposit. Mr. Wright visited barges to see working of his new fish-hatching boxes. Found wire too coarse and had to carry them back. Men were very successful in obtaining eggs, procuring 780,000. This caused us to place a large number in cylinders, cones being full.

May 18.—Clear and pleasant. Sent the cat-fish obtained the day previous to Prof. Baird, at the Smithsonian Institution. It was pronounced an Albino. Mr. Heywood left at 8 P. M., having received a dispatch calling him home. Turned 250,000 fish in Narrows at 6 P. M. Obtained 420,000 eggs at night.

May 19.—Overcast, with wind from N. E. Sent 250,000 fish above Havre de Grace at 9 A. M. Obtained 600,000 eggs at night. Prof. Ryder busily engaged over the development of young fish.

May 20.—Clear and warm. Sent 275,000 young fish above Havre de Grace at 9 A. M., and 200,000 at 3 P. M. Eggs coming out rapidly. No room for them in cones, so had to use cylinders. Placed 200,000 young fish, from eggs obtained on 15th, off mouth of Swan Creek, at 6.30 P. M. Obtained about 640,000 eggs at night.

May 21.—Clear and heavy wind from S. E. Sent 350,000 young fish, from eggs taken on 15th, above Havre de Grace, at 10 A. M. Delivered to Pennsylvania Fish Commission 250,000 young fish at 3 P. M. Placed 50,000 in river near

Pt. Deposit, and 25,000 in Narrows. Heavy gale from S. E., preventing the obtaining of eggs.

May 22.—Overcast, with heavy gale from S. E., causing very high tide and salt water to back up in Narrows. Lost about 300,000 young fish from this cause. Sent dispatch to this effect to Maj. Ferguson. Sent 460,000 young fish above Havre de Grace. Rain about 3 P. M., wind shifting to N. W., changing about 5.30 P. M. to East. Grass giving us great trouble, it having been broken up by heavy wind, by getting in pipes, preventing an even flow of water to cones. Placed 550,000 young fish in cylinders, as ordered, to be kept for shipment. Received dispatch in regard to departure of Machinery Barge No. 2, from Baltimore. Obtained 540,000 eggs at night.

May 23.—Showery, with light winds during day. Machinery Barge No. 2 arrived about 5.30 P. M., and was moored safely alongside other barges. Obtained about 560,000 eggs at night. Informed Maj. Ferguson of arrival of barge by telegraph.

May 24.—Clear and warm. All hands at work early arranging barges. Sent Launch No. 2 to Havre de Grace at 9 A. M. for Maj. Ferguson, who arrived about 12 M., bringing Mr. Rettig, a machinist, with him, to arrange machinery on Barge No. 2. Maj. Ferguson returned at 5 P. M., leaving Mr. Rettig. Sent men to gather spawn. They returned, bringing only 100,000 eggs, and stated that the gillers would not allow them to examine their fish unless they received 50c. each for spawning fish. No doubt they would have obtained a very large number of eggs had they been allowed to ex-

amine fish, as a great many ripe ones were reported.

May 25.—Clear and warm. Sent dispatch to Maj. Ferguson in regard to action of gillers. Mr. Rettig left at 7 P. M. having arranged machinery of Barge No. 2. Sent to Havre de Grace for shipment, 1,750,000 young fish, which were turned over to Mr. Simmons. Also sent three men to assist in taking care of them. There were 41 cans and 5 large cylinders. Received dispatch from Maj. Ferguson in regard to gillers, offering as an inducement to allow us to examine their fish, the following prizes: $50.00 to giller furnishing greatest number of ripe fish, $25.00 to second and $10.00 to third. Also ordered A. Hamlen and Jones to Washton. This left me with a small force mostly new men and they only obtained 240,000 eggs at night.

May 26.—Clear and warm. Sent A. Hamlin and Jones to Washington, furnishing them with transportation order. Transferred cones and fish to new Machinery Barge. Obtained only 80,000 eggs at night. Men reported great scarcity of male fish.

May 27.—Clear and very warm. Had men at work cleaning up and arranging Barge No. 2.—Turned 1,070,000 young fish in Narrows, not having cans in which to transport them above Havre de Grace. Obtained only 100,000 eggs from same cause as before stated. Do not think the prize system will work well, as the gillers seem averse to allowing spawn &c. taken, to be used save in their own boats.

May 28.—Clear and warm. Strong wind from S. E. about 1, P. M. Simmons returned with cans, &c.

Only obtained 40,000 eggs at night.

May 29.—Cool and clear. Sent 100,000 young fish to be placed in Bush River. Launch returned about 12 bringing Capt. Tanner and Machinest Barry. Capt. Tanner spent day in examining arrangement of cones and working of outside cylinders. He left in 4 P. M. train. Troubled again with backing up of salt water and requested him to so inform Maj. Ferguson. Ordered tug to come down early in morning to move us. Received 4 reflecting lamps for Barge No. 2. Obtained 220,000 eggs at night.

May 30.—Cloudy and damp. All hands taking up anchors preparatory to moving above Havre de Grace. Got under way in tow of tug about 9.30 A. M. and anchored above Havre de Grace off Watson's Island in about 30 feet water at 12.30 P. M. Heavy S. W. wind all day. Sent men down to gather eggs at night and obtained 80,000. Rain and wind prevented gillers from going out.

May 31.—Clear and strong wind from N. W. Received 10 transportation orders, and dispatch ordering Simmons to Washington with all transportation cans on hand. Accompanied men down to gather eggs and returned with 500,000 at 11 P. M.

June 1. Clear and pleasant. Received boxes containing jars &c. from Hatching house, Druid Hill Park. One of Winan and two of Ferguson jars broken. Prof. Ryder engaged most of day arranging for retardation of the hatching of shad eggs. Heavy storm with rain from N. W. about 7 P. M. Sent men to Battery whence they returned at 10.30 P. M. with

180,000 eggs. The storm prevented gillers from casting. Great scarcity of male fish reported.

June 2.—Cloudy and light rain during the forenoon. Engaged Collins and Myrtle from Havre de Grace to assist in taking spawn as directed by Maj. Ferguson. Sent men out at night and obtained 340,000 eggs. Scarcity of male fish prevented their doing better.

June 3.—Clear and pleasant. Machinist Barry busily engaged arranging machinery and engine. Went to Pt. Deposit accompanied by Prof. Ryder to examine specimen of fish reported caught there. It proved to be an Albino cat fish which we brought with us. Heavy squall with rain about 6.30 P. M. Very few gillers ventured out, so we only obtained 60,000 eggs.

June 4.—Clear and pleasant. Engine and machinery started about 5 P. M. working more regularly. Sent Prof. Baird the Albino cat fish by express by 9.52 train. Sent M. Gleason with 300,000 young fish on 12 M. train to Bush River. He returned at 4 P. M. Men obtained 680,000 eggs at night. They were placed in cylinder at 11 P. M.

June 5.—Overcast with heavy wind from S. Prof. Holman, a guest of Prof. Ryder's, arrived from Philadelphia. Had to stop engine on account of heavy sea, which interfered with cylinders. Prof's. Holman and Ryder accompanied spawn takers at night. Only obtained 160,000 eggs, the heavy sea running off the battery, preventing gillers from casting. Placed 485,000 young fish in river.

June 6.—Clear and pleasant. Machinery &c., moving smoothly. Prof. Holman left at 6 P. M.

Obtained 440,000 eggs which were placed in cylinders at 10.30 P. M.

June 7.—Clear and very warm. Cylinders working nicely and fish hatching rapidly. Placed 55,000 young fish overboard. Obtained 640,000 eggs at night, of which I placed 25,000 in Wright's boxes to hatch.

June 8.—Clear and pleasant. Gave Machinist Barry permission to go to Wilmington, Del., on business. Placed 650,000 young fish overboard. Eggs hatching out a greater proportion in cylinders than in cones. Obtained 220,000 eggs at night.

June 9.—Overcast and cool. Went to Havre de Grace with Prof. Ryder to weigh roe of shad, and found by calculation it contained at least 225,000 eggs. Maj. Ferguson, Mr. Stone of Cal., and Mr. Herbert Gill, arrived on 11.30 A. M. train. Mr. Gill engaged in settling accounts during day and left at 5.45 P. M., Maj. Ferguson and Mr. Stone leaving at 2.12 P. M. Obtained about 220,000 eggs at night. Large falling off in catch of fish reported.

June 10.—Raining. Capt. Tanner arrived at 12 M. Spent morning in examining construction of boats suitable for spawn taking. He left on 4.30 P.M. train for Wilmington, Del. Obtained 380,000 eggs at night.

June 11.—Clear and pleasant. Discharged Courtney and Hardy at their own request. Received dispatch to send fish to Baltimore. It was afterwards countermanded and one received to send 1,000,000 fish to Perryville, for shipment to Maine on 12th. The time for gilling having expired by law on the 10th, and having received orders not to send out after that date, obtained no more eggs. Very few men gilling and few fish taken.

June 12.—Clear and intensely warm. Thermometer at 9 A. M. 92°. Had all hands hard at work 1 P. M. taking up young fish for shipment. Terrific storm about 2.15 P. M. from N. W. with heavy rain, striking us with full force, causing us to break adrift and be driven ashore on bank of river. Lost 500,000 young fish overboard and 380,000 eggs nearly hatched; also, three anchors, chains, &c. Succeeded in getting 900,000 young fish safely to Perryville before the gale. Informed Maj. Ferguson by telegraph the result of the storm. Cleared away about 6 P. M. and had all hands at work hauling barges off. This we succeeded in safely doing at high-water, 11.30 P. M., and moored them safely alongside "Cochran's Ice House Wharf."

June 13.—Clear and very warm. Spent day fixing up. Had heavy squall and rain from N. W., about 4 P. M.

June 14.—Cool and pleasant. Maj. Ferguson arrived at 11.30 A. M. and returned at 1.30 P. M. Cast off from Ice House wharf and anchored in stream, as directed, at 6 P. M. Forwarded iron pieces, &c., to Maj. Ferguson, by express. Prof. Ryder left for Washington at 2 P. M.

June 15.—Raining. Discharged Captains Poplin and Farr, machinist Barry, engineers Woodland and Jeffries, and spawn-takers Freedy, Fletcher, Bailey, Mittendorff and Myrtle, whose accounts I forwarded Mr. Gill. Sent by express to Perry & Jones, cylinder with bottom &c., as ordered by Maj. Ferguson. Engaged most of day taking inventory of barge No. 2, and sent all bed linen &c., to be washed.

June 16.—Clear and pleasant. Light shower during afternoon. Sent hoisting engine to Washing-

ton, as ordered by dispatch. Took inventory of barge No. 1, and had paint &c., on sleeping barge all washed.

June 17.—Clear and pleasant. Sent Launch up and obtained ½ cord wood. The day was spent in cleaning up &c. Washing returned at night.

June 18. Clear and pleasant. Received five large boxes from Washington to store blankets &c., which we did, leaving full list inside.

June 19. Clear and pleasant. Day spent in clearing up.

There was nothing done afterwards but the sending of two of barges to Baltimore, in tow of Taylor's tug, and the remaining two left at wharf at Harve de Grace with Launch, in charge of M. Gleason, machinist Flynn, and fireman Spillman, of U. S. N.

MD. COMMISSION OF

RECORD OF OBSERVATIONS made at Spesutie Narrows, on the U.
by Jno. S.

Date.		Temperature of—									Depth of Water at Station.	Wind.		
Day of Week.	Day of Month.	Air.	Surface Water.	Bottom.	Air.	Surface Water.	Bottom.	Air.	Surface Water.	Bottom.		Direction.	Intensity.	Direction.
		7 a.m.			12 m.			7 p. m.				7 a. m.		12
Monday	3											S. W.	Strong	S. W.
Tuesday	4	60	65	63	72	66	63	65	66	63	15 to 25 ft.	S. W.	"	"
Wednesday	5	62	65	63	73	66	63	72	65	65		N. E.	"	E.
Thursday	6	61	64½	65	81	67	67	72	66	67		S. W.	"	N. W.
Friday	7	64½	65	65	79	68	68	61	67	67		S. E.	Gentle	S. E.
Saturday	8	63	65	64	68	68½	67	75	70	69		"	"	W.
Sunday	9	63	67	67	83	71½	69	79	72	72		S.	Calm	S. W.
Monday	10	73	69½	69½	83	72½	71½	78	73½	73½		"	Gentle	S.
Tuesday	11	71	71½	71½	81	73	72½	79	73½	73½		S. W.	"	S.S.W.
Wednesday	12	66	70½	70½	73	69	71	72	73½	73½		N.W.	Strong	N. W.
Thursday	13	61	68	67	62½	70	69	61	69	69		"	High	"
Friday	14	58	64	64	65	67	65	61	67	66		N.	"	N. E.
Saturday	15	52	60	60	60	64	64	63	65	64		N. E.	"	"
Sunday	16	62	61½	61½	72½	64	63½	76	66	65½		N.W.	Strong	S.S.W.
Monday	17	63	64½	64	85	67	66½	77	68	68		W.	Gentle	N. W.
Tuesday	18	70	67	66	82	71	71	79	72	71½		S. W.	Light	S. E.
Wednesday	19	61	67	66½	82	70	68	75	72	71½		N. E.	"	N. E.
Thursday	20	71½	69	69	85	73	71	80	72½	71½		"	"	"
Friday	21	73	71	71	80	73½	73	79	74½	74½		S. E.	Strong	S.
Saturday	22	73	71	69	81	73½	73½	69	74	74		S. W.	"	S. W.
Sunday	23	68	72	72	74	72½	72½	69	73½	73½		E.	Light	S. E.
Monday	24	71	73	73	85	75	74	80	75	75		N. E.	"	"
Tuesday	25	76	74	74	86	77	76½	82	79	79		S. W.	"	"
Wednesday	26	76	77½	78	96	82	79½	83	82	81½		"	"	S. W.
Thursday	27	83	80	79½	95	80	79½	87	82	81½		"	"	"
Friday	28	79	79	79	87	80½	80½	75	80	79½		W.	"	S. E.
Saturday	29	68	76	76	85	78	78	70	77	77		N. E.	Strong	E.
Sunday	30	73	76	76	70	78	78	68	76	76	35 to 40 ft.	S. E.	"	S. W.
Monday	31	73	76	76	83	77	76	80	77	77		N. W.	"	N. W.
Tuesday	June 1	73	73	72½	80	77	75	74	75	74		S. E.	Light	S. E.
Wednesday	2	58	74	74	80	74	74	76	72	72		N.W.	Strong	N. E.
Thursday	3	63	72	71½	86	69	68	78	71	71		"	Light	N. W.
Friday	4	72	71	70	84	71	71	80	71	71		"	"	N. E.
Saturday	5	69	74½	74	77	75	74	74	72	71½		S. E.	"	S. E.
Sunday	6	73	74	73½	78	74	73½	76	72	71½	35 to 40 ft.	S. W.	Strong	S. W.
Monday	7	84	74	74	89	77	75	79	75½	75		N. W.	Gentle	N. W.
Tuesday	8	75	73½	73	87	79	77	75	78	76		N. E.	Light	N. E.
						3 pm								
Wednesday	9	68	76	76	79	77	76	71	77	76		N. E.	Light	S. E.
Thursday	10	67	76	75	72	74	74	69	74	73		S. E.	"	"
Friday	11	64	72	71½	71	72	71½	80	73	72		"	"	"
Saturday	12	82	74	73½	92	79	77	82	78	76		N. W.	"	N. W.
Sunday	13	83	78	76	92	79	78	80	79	78		S. W.	"	S. W.
Monday	14	75	79	77	81	79	77	73	77	75		N. W.	Strong	N. W.
Tuesday	15	64	76	72	65	75	71	65	74	70		N. E.	"	E.

FISH AND FISHERIES.

S. Fish Commission Barges, from May 3d, 1880, to June 15th, 1880, Saunders.

Wind.			Condition of—				State of—			
Intensity.	Direction.	Intensity.	Sky.	Sky.	Sky.	Water.	Tide.	Tide.	Tide.	
m.	7 p. m.		7 a. m.	12 m.	7 p. m.		7 a. m.	12 m.	7 p. m.	
Strong	S. W.	Gentle	Clear	Clear	Clear	Cloudy	Ebb	Ebb	Flood	*a*
Gentle	"	"	"	"	"	"	"	"	"	
"	S. E.	"	Cloudy	Cloudy	"	Clear	Flood	"	"	
Strong	N. W.	"	Clear	Clear	"	"	"	"	"	
Gentle	S. E.	Strong	Overcast	"	"	"	"	"	"	
"	S. W.	Gentle	"	"	"	"	"	Slack	Ebb	
Strong	"	"	"	"	"	"	"	Flood	"	
"	S. S. W.	Strong	"	"	"	"	Slack	"	"	
"	W.	Gentle	"	Overcast	"	"	Ebb	"	"	
Gale	"	Gale	Clear	Clear	"	"	"	"	"	*b*
High	N.	High	"	"	"	Muddy	"	"	"	
Strong	N. E.	"	"	"	"	"	"	"	"	
"	W.	Gentle	"	"	"	"	"	"	"	
"	S. W.	"	Smoky	"	"	Clear	"	"	"	
"	"	"	Clear	"	"	"	"	"	"	
Light	S. E.	Light	"	"	"	"	"	"	"	
"	N. E.	"	Rain	"	"	"	"	Slack	"	
Strong	S. E.	Strong	Overcast	"	"	"	Flood	Ebb	Flood	
"	"	"	Clear	"	"	"	"	"	"	
"	E.	Light	Overcast	"	"	"	"	"	"	*c*
Light	N. W.	"	"	Showery	"	"	"	"	"	
"	S. W.	"	Clear	Clear	"	"	"	"	"	
"	"	"	"	"	"	"	"	"	"	
"	"	"	"	"	"	"	Ebb	Flood	Ebb	
"	S. E.	"	"	"	"	"	"	"	"	
Strong	N. W.	"	"	Overcast	"	"	"	"	"	*d*
Gentle	S. E.	"	"	"	Cloudy	"	"	"	"	
"	S. W.	"	Cloudy	Rain	Rain	"	"	"	"	*e*
Strong	S. E.	"	Clear	Clear	Clear	"	"	"	"	
"	N.	Strong	"	Overcast	Squall	"	"	"	"	
"	N. E.	"	Raining	"	Clear	Muddy	"	"	"	
"	N. W.	"	Clear	Clear	Stormy	"	"	Slack	"	
Light	N. E.	Light	"	"	Clear	"	Flood	Ebb	"	
Strong	S. E.	High	Overcast	Overcast	"	Clear	"	"	Flood	
High	S. W.	Light	Clear	Clear	"	"	"	"	"	*f*
Light	N. W.	Gentle	"	"	"	"	"	"	"	
"	E.	"	Clear	"	"	"	"	"	"	
Light	S. E.	Gentle	Overcast	Overcast	Overcast	Clear	Slack	Ebb	Flood	
"	N. W.	"	Rain	"	Rain	"	Flood	"	"	
"	S. W.	"	"	Clear	Clear	"	"	"	Ebb	
"	"	"	Clear	"	"	"	"	Flood	"	*g*
"	N. W.	"	"	"	"	"	Ebb	"	"	*h*
"	"	"	"	"	"	"	"	"	"	
Strong	N. E.	Strong	Raining	Raining	Raining	"	"	"	"	*i*

a. No thermometer to take temperature.
b. Very low tide.
c. Very high tide and water brackish. Rain about 3 p. m.
d. Rain about 5 p. m.
e. Moved barges to Watson's Island, above Havre de Grace, on account of salt water, at 10 a. m.
f. Very little tide; caused by river backing it down.
g. Terrible storm at 2.15 p. m., with terrific wind, causing barges to go adrift, losing 3 anchors and be driven high on rocks ashore.
h. Moved alongside Cochran's ice house wharf, having lost anchors in gale.
i. Heavy N. E. storm all day.

Md. COMMISSION OF FISH AND FISHERIES.

RECORD OF HATCHING OPERATIONS *conducted at Spesutie Narrows, Md., on the U. S. Barges, from 3d May, 1880, to 10th May, 1880, by Jno. S. Saunders.*

DATE.		SOURCES WHENCE FISH WERE OBTAINED.		FISH TAKEN BY—				RIPE FISH.		EGGS OBTAINED.	LOSS.		FISH HATCHED.	FISH DEPOSITED IN LOCAL WATERS.	FISH DEPOSITED IN OTHER WATERS.
				HAUL-SEINES.			GILL-NETS.								
DAY OF WEEK.	DAY OF MONTH.	Total length of haul-seines visited.	Total length of gill-nets visited.	No. Shad.	No. Herring.	Lbs. Rock.	No. Shad.	Males.	Females.		Eggs.	Fish.			
		Fathoms.	Fathoms.												
Monday	3	1,860		220	20,000			4	2	40,000	30,000		10,000	*a* 10,000	
Tuesday	4	1,860		334	15,000	250		19	13	475,000	25,000		250,000	250,000	
Wednesday	5	2,060	850	396	30,800		38	13	9	190,000	27,000		163,000	163,000	
Thursday	6	3,610		464	26,000			33	20	475,000	75,000		400,000	400,000	
Friday	7	3,610		689	36,300	24		26	17½	420,000	175,000		245,000	*b* 245,000	
Saturday	8	2,600	2,200	258	23,000		316	49	30½	600,000	60,000		540,000	540,000	
Sunday	9		2,150				271	21	15	300,000	30,000		270,000	270,000	
Monday	10	2,010	225	201	8,835	49	11	16	11½	230,000	15,000		215,000	*c* 215,000	
Tuesday	11	1,110	1,825	199	650	20	110	11	10	200,000	10,000		190,000		*d* 200,000
Wednesday	12		3,425				230	17	13	260,000	25,000		235,000	*e* 225,000	
Thursday	13		1,750				159	19	13	220,000	10,000		210,000	*f* 210,000	
Friday	14		2,100				316	26	17	345,000	20,000		325,000	*g* 325,000	
Saturyday	15		4,900				329	57	40	790,000	40,000		750,000	*h* 750,000	
Sunday	16		2,350				232	24	17	340,000	15,000		325,000	75,000	*i* 250,000

a. Eggs badly impregnated and a great many taken too young.

b. 150,000 eggs lost, by some one dropping coal oil in cone. Placed 10,000 young fish out in the Narrows, from eggs taken on 3d.

c. Placed 413,000 fish out in Spesutie Narrows on evening of 10th, hatched from eggs taken 4th and 5th.

d. Placed 250,000 fish in Spesutie Narrows. Placed 150,000 fish in above Havre de Grace, from eggs taken on 6th Delivered to Mr. Creveling on 15th.

e. Placed 100,000 fish in Spetsutie Narrows. Placed 145,000 fish above Havre de Grace, from eggs taken on 7th.

f. Placed 100,000 eggs in Spesutie Narrows. Placed 90,000 above Havre de Grace, from eggs taken on 8th. Shad taken very hard and not yielding full number of eggs.

g. Placed 270,000 above Havre de Grace, from eggs taken on the 9th.

h. Placed 215,000 above Havre de Grace, from eggs taken on 10th. Shad taken small and not yielding full number of eggs. Scarcity of males reported by some of men taking spawn.

i. On 21st delivered to Mr. Creveling.

RECORD OF HATCHING OPERATIONS conducted at Spesutie Narrows, Md., on the U. S. Barges, from 3d May, 1880, to 18th May, 1880, by Jno S. Saunders—Continued.

DATE.		SOURCES WHENCE FISH WERE OBTAINED.		FISH TAKEN BY—			RIPE FISH.		EGGS OBTAINED.	LOSS.		FISH HATCHED.	FISH DEPOSITED IN LOCAL WATERS.	FISH DEPOSITED IN OTHER WATERS.
				HAUL-SEINES.			GILL-NETS.							
DAY OF WEEK.	DAY OF MONTH.	Total length of haul-seines visited.	Total length of gill-nets visited.	No. Shad.	No. Herring.	Lbs. of Rock.	No. Shad.	Males.	Females.		Eggs.	Fish			
		Fathoms.	Fathoms.												
Monday	17	2,010	3,195	172	748		380	53	39	780,000	20,000	300,000	760,000 *k*	460,000	
Tuesday	18		2,050				167	24	21	420,000	40,000		380,000 *l*	240,000 *m*	140,000
Wednesday	19		3,150				252	40	30	600,000	40,000		560,000	*n*	560,000
Thursday	20		3,300				249	40	32	640,000	40,000		600,000	*o*	
Friday	21		2,100				180	30	24	480,000	30,000		450,000	*p*	
Saturday	22		2 925				219	33	27	540,000	15,000		525,000 *q*	525,000	
Sunday	23		2,575				257	33	26	560,000	15,000		545,000	545,000	
Monday	24		700				38	7	5	100,000	25,000	75,000	75,000 *r*		
Tuesday	25		1,900				131	14	12	240,000	90,000		150,000	1,050,000 *s*	150,000
Wednesday	26		825				52	6	4	80,000	60,000		20,000 *t*		
Thursday	27		1,000				143	5	5	100,000	70,000	50,000	30,000 *u*		
Friday	28														
Saturday	29		1,400				169	13	11	220,000	10,000		210,000	*w*	210,000
Sunday	30		400				50	6	4	80,000	5,000		75,000	*x*	75,000

k. Delivered to Commissioner of Fisheries of Pa. 200,000 young fish at 6 P. M. from eggs taken 11th and 12th. Lost 300,000 young fish by salt water being backed up by heavy S. E. storm on 18th. *l.* Placed in cylinder overboard on 22d, to keep as per Maj. Ferguson's order. *m.* Placed 240,000 young fish in Spesutie Narrows about 6 P. M., from eggs taken on 12th. *n.* Placed 560,000 young fish above Havre de Grace from eggs taken on 14th and 14th, at 10 A. M. *o.* Placed 600,000 young fish above Havre de Grace from eggs taken on 14th, at 10 A. M. *p.* Placed 450,000 young fish above Havre de Grace from eggs taken on 14th. Placed 75,000 young fish in Swan Creek from eggs taken on 13th. *q.* Placed 150,000 young fish above Havre de Grace from eggs taken on 13th. Placed 375,000 young fish above Havre de Grace from eggs taken on 12th. Delivered 150,000 young fish to Pa. Commissioner on 18th. *r.* Placed 1,050,000 young fish above Havre de Grace from eggs of 17th. *s.* Strike among gillers for 10c. apiece for ripe fish, which accounts for few eggs taken. Placed 240,000 young fish in Narrows from eggs of 18th. *t.* Sent to Havre de Grace for shipment 1,750,000 young fish from eggs of 18, 19, 20 and 21st. Great scarcity of male fish reported. *u.* Eggs taken very bad, being badly impregnated by scarcity of males. Lost good quantity by new hatching boxes of Mr. Wright. *w.* Placed out in Narrows 1,070,000 young fish from eggs of 22d and 23d. Could not send above Havre de Grace for want of cans. Eggs badly impregnated. *x.* Sent 180,000 young fish for distribution Bush River from eggs of 25th. *z.* Storm at night, few gillers out. Moved Barges to Watson's Island on account of salt water at 10 A. M.

RECORD OF HATCHING OPERATIONS conducted at Spesutie Narrows, Md., on the U. S. Barges, from 3d May, 1880, to 18th May, 1880, by Jno. S. Saunders—Continued.

DATE.		SOURCES WHENCE FISH WERE OBTAINED.		FISH TAKEN BY—				RIPE FISH.		EGGS OBTAINED.	LOSS.		FISH HATCHED.	FISH DEPOSITED IN LOCAL WATERS.		FISH DEPOSITED IN OTHER WATERS.
				HAUL-SEINES.			GILL-NETS.									
DAY OF WEEK.	DAY OF MONTH.	Total length of haul-seines visited.	Total length of gill-nets visited.	No. Shad.	No. Herring.	Lbs. of Rock.	No. Shad.	Males.	Females.		Eggs.	Fish.				
		Fathoms.	Fathoms.													
Monday	31		2,100				229	27	25½	510,000	25,000		485,000	485,000		
Tuesday	1		675				58	10	9	180,000	20,000		160,000	160,000	*y*	
Wednesday	2		2,700				179	20	17	340,000	40,000		300,000	300,000		
Thursday	3		400				45	3	3	60,000	5,000		55,000	55,000	*b*	
Friday	4		3,000				210	37	34	680,000	30,000		650,000	650,000	*c*	
Saturday	5		1,700				62	12	8	160,000	20,000		140,000	140,000	*d*	
Sunday	6		1,825				241	29	22	440,000	40,000		400,000	400,000	*e*	
Monday	7		4,600				557	40	32	640,000	40,000		600,000			*f* 600,000
Tuesday	8		1,400				52	13	11	220,000	20,000		200,000			*g* 200,000
Wednesday	9		1,580				91	17	11	220,000	20,000		200,000	100,000		*h* 100,000
Thursday	10		2,400				86	24	19	380,000	20,000		360,000	360,000		
		2,0730	48,201	2,953	101,353	343	9,100	871	660	15,355,000	1247,000	4,3,000	13,058,000	9,148,000		2,485,000

y. Heavy storm preventing many gillers from going out. *z*. Heavy squall preventing gillers from laying out. *a*. Placed 485,000 young fish in Bush River from eggs taken on 28th and 30th May. *d* Lost out in river 485,000 young fish by overflow of cylinders and break in wire bottom, from eggs of 31st May. Heavy gale from S. W. preventing gillers going out. *e*. Placed in river 400,000 young fish, from eggs of 1st and 2nd. *f*. Placed in river 35,000 young fish, from eggs of 3rd. *g*. Placed in river 650,000 young fish, from eggs of 4th. *h*. Placed 140,000 young fish in river from eggs 5th.

Placed 400,000 young fish on flats opposite Watson's Island on 12th, from eggs of 6th.

Shipped 900,000 young fish at 2 P. M. on 12th to go to Maine, from eggs of 7th, 8th and 9th.

Turned out 100,000 young fish, which were intended to be shipped to Maine, but storm prevented.

Had terrific storm on 12th at 2:15 P. M., causing barges to drag anchor, and break chains of three, causing us to lose eggs of 12th, which were nearly out and barges to go ashore.

RECORD OF DISTRIBUTION OF SHAD *made from May 7th, 1880, to June 27th, 1880, by Maryland Fish Commission under direction of T. B. Ferguson, Commissioner.*

Date of Leaving Station.		Date Fish Placed in Stream Stock'd		Number of Fish.							
Day of Week.	Day of Month.	Day of Week.	Day of Month.	Originally Taken	Actually Planted	State.	Place.	Stream.	Tributary of	Transfer in Charge of	
Friday	May 7	Friday	May 7	10,000	10,000	Md.	Spes'c Nar.	Susquen'a	C. Bay	Jno. S. Saunders	
Saturday	" 8	Saturday	" 8	335,000	335,000	"	Wash, D.C.	E. br. Pot.	Pot'c	Wm. P. Sauerhoff	
Saturday	" 8	Saturday	" 8	300,000	300,000	"		Patuxent	C. Bay	C. W. Schuermann	
Sunday	" 9	Sunday	" 9	50,000	50,000	"	Wash, D.C.	E. br. Pot	Pot'c	Wm. P. Sauerhoff	
Monday	" 10	Monday	" 10	413,000	413,000	"	Spes'c Nar.	Susquen'a	C. Bay	Jno. S. Saunders	
Tuesday	" 11	Tuesday	" 11	250,000	250,000	"	"	"	"	" " "	
Tuesday	" 11	Tuesday	" 11	150,000	150,000	"	H. de Grace	"	"	" " "	
Tuesday	" 11	Tuesday	" 11	110,000	110,000	"	Wash, D.C.	E. br. Pot.	Pot'c	C. W. Schuermann	
Tuesday	" 11	Tuesday	" 11	200,000	200,000	"		Patuxent	C. Bay	W. H. Jenkins, Jr.	
Wednesday	" 12	Wednesday	" 12	145,000	145,000	"	H. de Grace	Susquen'a	"	Jno. S. Saunders	
Wednesday	" 12	Wednesday	" 12	100,000	100,000	"	Spes's Nar.	"	"	" " "	
Thursday	" 13	Thursday	" 13	190,000	190,000	"	"	"	"	" " "	
Thursday	" 13	Thursday	" 13	350,000	350,000	"	H. de Grace	"	"	" " "	
Friday	" 14	Friday	" 14	270,000	270,000	"	"	"	"	" " "	
Saturday	" 15	Saturday	" 15	215,000	215,000	"	"	"	"	" " "	
Saturday	" 15	Saturday	" 15	60,000	60,000	"		Potomac	"	C. W. Schuermann	
Saturday	" 15	Saturday	" 15	300,000	300,000	"	Cumberla'd	Potomac	"	H. E. Quinn	
Sunday	" 16	Sunday	" 16	20,000	20,000	"	Wash, D.C.	E. br. Pot.	Pot'c	C. W. Schuermann	
Sunday	" 16	Sunday	" 16	300,000	300,000	"	Savage	Patuxent	C. Bay	Newton Simmons	
Monday	" 17	Monday	" 17	100,000	100,000	"	Wash, D.C.	E. br. Pot.	Pot'c	C. W. Schuermann	
Monday	" 17	Monday	" 17	300,000	300,000	"	Pt. of Rocks	Potomac	C. Bay	J. F. Ellis	
Tuesday	" 18	Tuesday	" 18	200,000	200,000	"	Wash, D.C.	E. br. Pot.	Pot'c	C. W. Schuermann	
Tuesday	" 18	Tuesday	" 18	225,000	225,000	"	Spes'c Nar.	Susquen'a	C. Bay	Jno. S. Saunders	
Wednesday	" 19	Wednesday	" 19	250,000	250,000	"	H. de Grace	"	"	" " "	
Thursday	" 20	Thursday	" 20	400,000	400,000	"	Wash, D.C.	E. br. Pot.	Pot'c	Sauerhoff & Hamlen	
Thursday	" 20	Thursday	" 20	285,000	285,000	"	H. de Grace	Susquen'a	C. Bay	Jno. S. Saunders	

RECORD OF DISTRIBUTION OF SHAD *made from May 7th, 1880, to June 27th, 1880, by Maryland Fish Commission under direction of T. B. Ferguson, Commissioner.*—Continued.

Date of Leaving Station		Date Fish Placed in Stream Stock'd		Number of Fish.						
Day of Week.	Day of Month.	Day of Week	Day of Month	Originally Taken.	Actually Taken.	State.	Place.	Stream.	Tributary of	Transfer in Charge of
Thursday	May 20	Thursday	May 20	200,000	200,000	Md.	H. de Grace	Susquen'a	C. Bay	Jno. S. Saunders
Thursday	" 20	Thursday	" 20	200,000	200,000	"	Swan Creek	"	"	" " "
Friday	" 21	Friday	" 21	350,000	350,000	"	H. de Grace	"	"	" " "
Friday	" 21	Friday	" 21	50,000	50,000	"	"	"	"	" " "
Friday	" 21	Friday	" 21	25,000	25,000	"	Spes'c Nar.	"	"	" " "
Friday	" 21	Friday	" 21	200,000	200,000	"	Wash, D.C.	E. br. Pot.	"	Sauerhoff & Hamlen
Friday	" 21	Friday	" 21	600,000	600,000	"	Savage	Patuxent	"	J. F. Ellis
Saturday	" 22	Saturday	" 22	460,000	460,000	"	H. de Grace	Susquen'a	"	Jno S. Saunders
Saturday	" 22	Saturday	" 22	600,000	600,000	"	Wash. D.C.	E. br. Pot.	Pot'c	C. W. Schuermann
Saturday	" 22	Saturday	" 22	200,000	200,000	"		Potomac	C. Bay	Sauerhoff & Hamlen
Sunday	" 23	Sunday	" 23	25,000	25,000	"		"	"	" "
Monday	" 24	Monday	" 24	800,000	800,000	"	Wash, D.C.	E. br. Pot.	Pot'c	Clark & Schuermann
Monday	" 24	Monday	" 24	240,000	240,000	"	Spes'c Nar.	Susquen'a	C. Bay	Jno. S. Saunders
Tuesday	" 25	Tuesday	" 25	400,000	400,000	"	Wash, D.C.	E. br. Pot.	Pot'c	F. N. Clark
Tuesday	" 25	Tuesday	" 25	500,000	500,000	"	Moxley's Pt	Potomac	C. Bay	Sauerhoff & Hamlen
Tuesday	" 25	Tuesday	" 25	1,050,000	1,050,000	Del.	Seaford	Nanticoke	"	N. Simmons
Tuesday	" 25	Tuesday	" 25	500,000	500,000	Md.	Savage	Patuxent	"	C. W. Schuermann
Wednesday	" 26	Wednesday	" 26	500,000	500,000	"	Moxley's Pt	Potomac	"	Sauerhoff & Hamlen
Wednesday	" 26	Wednesday	" 26	1,500,000	1,500,000	"	Laurel	Patuxent	"	C. J. Huske
Wednesday	" 26	Wednesday	" 26	400,000	400,000	"	Wash, D.C.	E. br. Pot.	Pot'c	C. W. Schuermann
Thursday	" 27	Thursday	" 27	450,000	450,000	"	"	"	"	F. N. Clark
Thursday	" 27	Thursday	" 27	1,070,000	1,070,000	"	Spes'c Nar.	Susquen'a	C. Bay	Jno. S. Saunders
Friday	" 28	Friday	" 28	75,000	75,000	"	"	"	"	" " "
Friday	" 28	Friday	" 28	150,000	150,000	"	Wash, D.C.	E. br. Pot.	Pot'c	F. N. Clark
Saturday	" 29	Saturday	" 29	150,000	150,000	"		Bush Riv.	C. Bay	Newton Simmons
Saturday	" 29	Saturday	" 29	50,000	50,000	"	Deer Park	L. Yong'g	Yon'g	S. M. Rixey

RECORD OF DISTRIBUTION OF SHAD *made from May 7th, 1880, to June 27th, 1880, by Maryland Fish Commission under direction of T. B. Ferguson, Commissioner* —Continued

Date of Leaving Station		Date Fish Placed in Stream		Number of Fish.						
Day of Week.	Day of Month	Day of Week.	Day of Month.	Originally Taken.	Actually Planted.	State.	Place.	Stream.	Tributary of	Transfer in Charge of
Saturday	May 29	Saturday	May 29	200,000	200,000	Md.	Wash, D.C	E. br Pot.	Pot'c	F. N. Clark
Tuesday	June 1	Tuesday	June 1	30 000	30,000	"	Wash D C.	E br. Pot.	Pot'c	F. N. Clark
Wednesday	" 2	Wednesday	" 2	50 000	50 000	"	Off Wat. It	Susquen'a	C. Bay	John S. Saunders
Wednesday	" 2	Wednesday	" 2	275.000	275 000	"	Moxley's Pt	Potomac	"	W. P. Sauerhoff
Thursday	" 3	Thursday	" 3	285 000	285 000	"		Bush Riv.	"	M Gleason
Friday	" 4	Friday	" 4	485.000	485 000	"	Off Wat It.	Susquen'a	"	John S Saunders
Friday	" 4	Friday	" 4	500 000	500 000	"	Little Falls	Potomac	"	Frank N. Clark
Friday	" 4	Friday	" 4	175.000	175 000	"	Wash D C.	E br. Pot.	Pot'c	" " "
Saturday	" 5	Saturday	" 5	600 000	600.000	"	Little Falls	Potomac	C. Bay	Wm. H. Jenkins, Jr.
Saturday	" 5	Saturday	" 5	300 000	300 000	"	Wash D C.	E. br. Pot	Pot'c	F. N. Clark
Sunday	" 6	Sunday	" 6	460.000	460 000	"	Off Wat. It.	Susquen'a	C. Bay	John S. Saunders
Sunday	" 6	Sunday	" 6	300 000	300 000	"	Wash. D C	E. br. Pot	Pot'c	F. N. Clark
Monday	" 7	Monday	" 7	55 000	55 000	"	Off Wat. It	Susquen'a	C. Bay	John S. Saunders
Monday	" 7	Monday	" 7	375 000	375 000	"	Savage	Patuxent	"	S. M. Rixey
Tuesday	" 8	Tuesday	" 8	650.000	650 000	"	Off Wat It.	Susquen'a	"	John S Saunders
Tuesday	" 8	Tuesday	" 8	400 000	400 000	"	Little Falls	Poto nac	"	S. M. Rixey
Wednesday	" 9	Wednesday	" 9	140 000	140.000	"	Off Wat. It	Susquen'a	"	John S. Saunders
Wednesday	" 9	Wednesday	" 9	100 000	100 000	"	Ft. Wash'n	Potomac	"	Wm. P. Sauerhoff
Saturday	" 12	Saturday	" 12	400 000	400 000	"	Off Wat. It.	Susquen'a	"	John S. Saunders
Saturday	" 12	Saturday	" 12	100,000	100 000	"	" " "	"	"	" " "
Saturday	" 12	Saturday	" 12	75.000	75 000	"	Wash. D C	E. br. Pot.	Pot'c	F. N. Clark
Saturday	" 12	Saturday	" 12	500 000	500 000	"	Little Falls	Potomac	C. Bay	W. H. Jenkins, Jr.
Sunday	" 13	Sunday	" 13	175,000	175,000	"	Used for experiments			F. N. Clark
Sunday	" 13	Sunday	" 13	300,000	300.000	"	Wash. D C.	E. br. Pot	Pot'c	" " "
Monday	" 14	Monday	" 14	85 000	85,000	"	Used for experiments			" " "
Friday	" 18	Friday	" 18	50,000	50,000	"	Used for experiments			" " "

RECORD OF DISTRIBUTION OF SHAD *made from May 7th, 1880, to June 27th, 1880, by Maryland Fish Commission under direction of T. B. Ferguson, Commissioner.*—Continued.

Date of Leaving Station.		Date Fish Placed in Stream Stock'd		Number of Fish.					Tributary of	Transfer in Charge of
Day of Week.	Day of Month.	Day of Week.	Day of Month.	Originally Taken.	Actually Planted.	State.	Place.	Stream.		
Saturday	June 19	Saturday	June 19	100,000	100,000	Md.	Used for experiments			F. N. Clark
Tuesday	" 22	Tuesday	" 22	160,000	160,000	"	Used for experiments			" " "
Sunday	" 27	Sunday	" 27	100,000	100,000	"	Mov'd to S'm's. In. for		expri's	" " "
				23,498,000	23,498,000					

In order to insure the active co-operation of the gill-net fishermen, the U. S. Commissioner has for several years generously paid to the gillers fifty cents for each ripe female shad delivered immediately as it was taken from the net. The fish were invariably returned to the fishermen, after the eggs had been taken, and as this operation caused no perceptible injury to the fish, the premium was a strong incentive to the co-operation of the fishermen, as it was a source of considerable profit to them.

The Maryland Fish Commission has never consented to pay any thing for the privilege of taking spawn from captured fish, as it has considered it but just that the fishermen should co-operate in a work intended for their future benefit. The U. S. Commissioner, however, has made this contribution to the fishermen on the ground that a portion of the fish produced from these eggs were subject to be shipped to other waters; but as the forces employed by the two Commissions were operated as one and the work conducted jointly, the U. S. Commissioner has paid for all the spawn obtained from fish taken in the gill-nets.

As the work increased from year to year this premium for the ripe shad became a considerable tax on the U. S. Commissioner, and it was determined that the amount paid should be reduced to twenty-five cents for each spawning shad, and due notice was given to the gillers during the season of 1879 that such a reduction would be made the following season. Even this reduced premium was a very liberal compensation for the small trouble the gillers were put to. I was, therefore, both surprised and mortified when, in the midst of the season, the fishermen refused to allow not only those employed by the U. S. Commission, but those also of the Maryland State Commission as well, to take eggs from their fish.

This conduct on the part of the fishermen might have caused a very decided diminution in the number of fish

turned loose in these waters, had not the U. S. Commissioner again come to our aid and satisfied the fishermen by offering them other inducements for furnishing ripe fish.

As this "strike," as it may be designated, took place in the very height of the season, the number of fish produced at this station was no doubt diminished by several millions.

I cannot but condemn the short-sighted policy which instigated such action on the part of our fishermen: for the results of the work—especially in this locality—have been such as to convince the most skeptical among them of our capacity to increase shad to a very marked extent, and thereby, to correspondingly increase their crop.

The number of young fish produced at the Havre de Grace station—notwithstanding the adverse conditions of the season, and the interruption of the work from the causes above mentioned—reached 12,058,000. Of these 9,148,000 were deposited in the Maryland waters and 2,485,000 transported to other waters by the U. S. Commission.

The details of the distribution of the fish produced at this station as well as those hatched at the Navy Yard, and on the Steamer "Lookout," will be found on page 43 *et seq.*

It will be seen that the number deposited in Maryland waters reaches the total aggregate of 23,498,000.

HERRING—*Clupeida*.

The commercial importance of this family, and the ease with which it can be increased in those localities where it is diminishing and re-established in streams from which it has entirely disappeared, mark it as an object not only of our care, but close consideration and study.

On the Atlantic coast of the United States occur nine fishes belonging to the herring tribe. Four of these, the sea-herring, a fish of much economic importance on both

sides of the Atlantic, the menhaden, another fish of extreme importance from Maine to Virginia, the thread-herring and the round-herring, insignificant species of no particular value, are found solely in the sea. One, the mud-shad, or gizzard-shad, is found in brackish water, from Cape Cod to Florida, while four others live both at sea and in the rivers, and by their peculiar habit of breeding in the rivers and feeding at sea are of the utmost importance to the river fisheries. These are the shad, the hickory-shad, or tailor-herring, and the two species of river herring. The two species of river herring have, for many years previous to 1879, been considered as identical, or, to speak more exactly, although fishermen have had decided opinions that there were two different kinds, this fact had not been demonstrated to the satisfaction of naturalists. Recent observations, however, have demonstrated very satisfactorily that there are two species, which, besides presenting marked and characteristic differences, are very different in their habits. One of them, the gray-back herring of Massachusetts, the branch herring of the Chesapeake waters, the Gaspereau (*pomolobus vernalis*) of Canada, appears to enter the rivers earlier than the other species. In the Chesapeake, the schools are said to be smaller, and they spawn higher up in the creeks. The other species, the glut-herring of the Chesapeake, the black-belly of Massachusetts, also known to New England fishermen by the names "saw-belly," "Kyack," and "cat-thrasher" (*pomolobus æstivalis*), is later in its runs, and swims in larger schools near the mouths of the creeks. The name glut-herring, indeed is said to refer to the fact that the schools of fish are so large that they fill up or glut the mouths of small streams, as well as the markets of the vicinity, while, on the other hand, the name branch-herring has reference to the fact that the other species goes up to the heads of creeks or branches. The glut-herring seems to be more widely distributed at sea along

the coast of the United States, and they are frequently taken in great quantities in the mackerel nets of the Gulf of Maine, as well as the pounds along the coast. The geographical distribution of the two species, as now understood, is quite different. Both species occur in the Chesapeake Bay and its tributaries, and both together as far north as the Bay of Fundy and perhaps the southern part of the Gulf of Saint Lawrence. The glut-herring, however, is found south of the Chesapeake, even as far as the Saint John River of Florida, while the branch-herring, under the name of Gaspereau, occurs the entire length of the Gulf of Saint Lawrence and throughout Lake Ontario. It is somewhat difficult to distinguish the two species by external characters, the best distinction being in the color of the lining of the abdomen, which is black in the glut-herring and gray in the branch-herring. The former is also distinguished by its elongated form, lower body, less elevated fins, smaller eyes, and the different proportions of the bones of the head. It may be interesting in this connection to note the statement of two careful observers in Massachusetts, at the same time remarking that the subject is not thoroughly understood, and that further investigations may bring to light still other species related to those already described.

In an account of the "Topography and History of Wareham, Mass." (*Coll. Mass. Hist. Soc., Vol. IV.*, 1875, *2d series*, *pp.* 294–296,) is the following account of the two species of alewives, or herrings, which is interesting, since it is the first recorded instance of any discrimination between them:—

"Of the alewife there are evidently two kinds, not only in size, but habits, which annually visit the brooks, passing to the sea at Wareham. The larger, which set in some days earlier, invariably seek the Weweantic sources. These, it is said, are preferred for the present use, perhaps, because they are the earliest. The second

less in size, and usually called 'black backs,' equally true to instinct, seek the Ogawam." The "black back" here referred to is doubtless the "glut-herring" of the Chesapeake region.

Col. Theodore Lyman, in his report as Commissioner of Fisheries for Massachusetts for the year ending Jan. 1, 1869, gives the following results of observations in various rivers of Massachusetts: "The netters recognize several sorts and several runs of alewives. The *river herring* is a large variety, not much esteemed, and supposed to spawn in tidal water. These are always most numerous in streams that have bad fishways; because, when once they have spawned *below* a dam, the progeny are not inclined to go farther, and lie in tidal waters. Large shoals of these "sulkers" may be seen at Squawbetty, on Taunton Great River, or at the foot of the dam, on Mystic Pond. Then there are the *gray-backs* and the *black bellies*, which have all the marks of a distinct species. * * * * * * * The *black-bellies* appear later in the season than the *gray-backs*, and though smaller are, by reason of their fatness, more esteemed."

Whenever the opportunity has occurred I have caused the spawn of the herring to be taken, and have tried several experiments in order to secure the best methods for propagating them, and have succeeded in hatching many hundred thousand, which have been returned to our waters. But for reasons stated in my previous Reports, no special hatching station has been established for the propagation of this fish, but this is in the program of the future.

Figures of the several species of this family are given in order that their peculiarities of form may be carefully studied, for it is most advisable that those employed in the work of fish culture who undertake the propagation of the herring should be able to distinguish especially between the glut-herring (*pomolobus æstivalis*) and the

branch-herring (*p. vernalis*); for if the opportunities of propagating the two be equal the former should most certainly be selected as the more valuable variety.

The difference in the spawning habits of these two species has no doubt contributed very materially to the disappearance of the glut-herring and the continued abundance of the branch-herring, the latter seeking more isolated localities, where they are less disturbed by the fishermen, than the former.

Although the catch of herring during the last season was unusually large, yet, unfortunately, it consisted principally of the branch-herring or the less valuable variety.

Col. McDonald reports that "on the Neuse the catch of branch-herring (*p. vernalis*), or wall-eyed, as it is called by the fishermen on that river, was unusually large; sometimes the catch of a drag-net was almost wholly of this species. The run of glut-herring was very small. On the Albemarle the same condition of things existed, the large proportion being of the *vernalis* and males, being much smaller than the glut-herring.

On the Rappahannock the only considerable run of herring was the *vernalis*. These were largely male, and very small, requiring about 1100 to the barrel."

"On the Susquehanna there was a herring glut from the 1st to the 10th of May. These also were the *vernalis*, mostly males, and very small, as on the Rappahannock."

Hatching House.

The fish hatched during the year 1879 had all been distributed by the 1st of January, 1880, with the exception of twelve thousand seven hundred (12,700) California salmon, and eight hundred and seventy-five (875) young carp. A few Penobscot salmon, land-locked salmon, and brook-trout, were left in the brick ponds adjacent to the hatching-house.

The water supplying these ponds is mainly received from the high-surface reservoir located on the hill to the

west of the hatching-house, where it is exposed to the action of the sun and atmosphere and reaches a very high temperature during the heated term.

Hitherto we had found it impracticable to keep the salmonidæ in these small ponds except in comparatively cool summers. I determined, however, to make another effort to keep over the fish referred to, but am now satisfied that these ponds can be better utilized for the rearing of other varieties which do not require such cold water. Almost all of the fish reserved for this experiment died during the summer.

SALMON—*Salmo salar.*

There were also on hand at the hatching-house sixty thousand eggs of the Penobscot salmon, which commenced to hatch on the 10th of the month, the hatching being completed by the 15th of February, when all the young fish were free from the egg. As this variety had been so successfully introduced into the Delaware River, and a few adults had been taken in the Susquehanna River on their return from the ocean, I deemed it advisable to secure as many eggs as possible for the principal waters of Maryland, and the U. S. Commissioner generously furnished us with the sixty thousand above mentioned, for the waters of the Susquehanna and the Potomac, as it was thought best to put all the fish into the tributaries of these two streams. It was arranged with the Commissioners of Pennsylvania, therefore, that I should hatch at Druid Hill Park the fish intended for the Susquehanna River, and that they should be transported to the headquarters of the Susquehanna by that commission and deposited in the tributaries of that stream. In accordance with this arrangement, on the 23rd of March I delivered to Mr. J. P. Creveling, the agent of the Pennsylvania Commission, twenty-three thousand of these fish, being the yield of one-half of the eggs received, to be disposed of as above indicated. I approved of this arrangement, as I was satisfied that the

upper waters of the Susquehanna could be more readily reached through the aid of the Pennsylvania Commissioners, who were familiar with the localities best suited for the salmon during their stay in the river, and that by placing them as high up the stream as was possible their chances of existence would be very much increased. The sources of the Potomac River and of its tributaries within the State were easier of access, and the distribution of the fish intended for that river was effected under the auspices of the Maryland Commission.

The fish produced from the above-mentioned 60,000 salmon eggs were deposited as follows:—

On March	23	23,000	Upper Waters of Susquehanna	by J. P. Creveling
"	"	24 3,000	in the Monocacy	by Wm. H. Jenkins, jr
" April		5 10,000	" N. Fork Potomac	by Wm Hamlen
"	"	6 10,000	" S. Fork Potomac	by Wm. H. Jenkins, jr
"	"	9 5,000	" Conococheague	by Wm. Hamlen
"	"	9 7,729	" Monocacy	by Wm. H. Jenkins, jr
Total.		58,729		

Land-locked Salmon.

On the 22nd of January a gift of twenty-five thousand (25,000) eggs of the land-locked salmon was received from the U. S. Commissioner, being part of a lot collected by him from Grand Lake stream, Maine. As this variety of the salmon family has lost its propensity for migrating to the ocean, its introduction into the streams and ponds of the State has been attempted, with special regard for those portions of the State which are drained by the tributaries of the Ohio River. The experiments tried with this fish in the ponds at Druid Hill Park would indicate that it is better adapted to withstanding extremes of heat than is any other variety of the same family. As it attains a larger size and grows more rapidly than the brook-trout its domestication in trout streams is much to be desired.

The disposition made of the fish produced from this lot of eggs is indicated in the accompanying table:—

RECORD OF DISTRIBUTION OF LAND-LOCKED SALMON *made from March 22d, 1880, to August 9th, 1880, by Maryland Fish Commission.*

Day of Month.	Number of Fish.	State.	Place.	Stream.	Tributary of—	Fish Delivered to—
Mar. 22.	200	Md.	Buckeystown	Pond	Monocacy	Chas. S. Simmons.
April 5.	3000	"	Oakland	L. Yough	Potomac	Wm. Hamlen
" 15.	500	"	Buckeystown	Pond	Monocacy	Chas. S. Simmons.
" 18.	500	"	Pikesville	"	Gwynn's Falls	Thos. J. Meyer.
" 19.	500	"	Green Spring Val.	"	L. Roland	S. S. Clayton.
" 19.	500	"	Carrollton	"	Patapsco Falls	S. W. Wilderson.
" 20.	500	"	Oakland	"	Patuxent River	C. Francis Dixon.
" 20.	500	"	Baltimore	"	" "	G. W. Ridgely.
" 20.	500	"	Airy Hill	"	Gwynn's Falls	H. W. Graue.
" 20.	500	"	Baltimore	Trout Branch	Patuxent River	S. P. Easter.
" 21.	500	"	Unionville	Pond	Linganore Creek	Wm. G. Wilson.
" 22.	500	"	Wilna	Winter's Run	Bush River	Edw. Hollingsworth.
" 24.	500	"	Baltimore	Pond	Gunpowder	P. T. George.
" 26.	500	"	Near Catonsville	"	Gwynn's Falls	Jno. R. Long.
" 28.	500	"	Clearspring	Mill Dam	Potomac River	S. M. Reitzell.
" 28.	500	"	Bel Air	Pond	Bush River	Alex. M. Fulford.
" 30.	500	"	Eden	"	Patapsco River	Chas. E. Lanver.
May 1.	500	"	Baltimore	Patuxent River	Chesapeake Bay	W. H. Baldwin, Jr.
" 4.	200	"		Dripping Spri'g	Gunpowder	D. R. Howard.
" 6.	500	"	Long Green Val.	Pond	B. Gunpowder	Edw. F. Jenkins
" 8.	500	"	Norrisville	"	Deer Creek	J. Benson Gable.
" 11.	500	"	Frederick	"	Potomac	Danl. Mainhart.
" 13.	500	"	Mt. Pleasant	"	Monocacy	Martin Hoke.
" 14.	500	"	Denton	"	Choptank	Jas. E. Hignutt.
" 17.	500	"	Baltimore	"	Gunpowder	S. Baldwin.
" 18.	500	"	Fairview	Bush Run	Conocheague	Jos. C. Herschberger.
" 18.	500	"	Sulphur Spring	Pond	Patapsco	Henry Cragg.
" 24.	500	"	York Road	"	Gunpowder	Mrs. J. F. C. Talbott.

RECORD OF DISTRIBUTION OF LAND-LOCKED SALMON *made from March 22d, 1880, to August 9th, 1880, by Maryland Fish Commission*—Continued.

Day of Month.	Number of Fish.	State.	Place.	Stream.	Tributary of—	Fish Delivered to—
May 27.	500	Md.	Sandy Spring	Pond	Patuxent River	Ernest Lawford.
" 27.	500	"	Sandy Spring P. O.	"	North West River	Geo. B. Miller.
	16,900					

CALIFORNIA SALMON—*Oncorhynchus quinnat.*

The experiments of hatching the eggs of the California salmon in floating boxes were renewed in the north branch of the Potomac at the point near its source, which had been selected the preceeding fall, and was attended with equally successful results.

About 200,000 eggs were obtained from the U. S. Commissioner of Fish and Fisheries. These were landed at Oakland and transported thence in a wagon to the point indicated, where they were hatched and the young fish protected until the sac was sufficiently absorbed, when they were liberated in the Potomac between the hatching station and Fort Pendleton.

An account of the work at this place in detail will be found in the accompanying table:—

MD. COMMISSION OF FISH AND FISHERIES.

RECORD OF SALMON HATCHING OBSERVATIONS made at North Branch, on the Potomac River, from October 13th, 1880, to November 22nd, 1880, by E. H. Walke.

Date.		Temperature of—									Depth of water at station	Wind.						Condition of—			Loss.		Fish Hatched	Remarks.
		7 a. m.			12 m.			5 p. m.				Direction		Direction		Direction		Sky	Water	Tide (River)	Eggs	Fish		
Day of Week	Day of Month	Air	Surface Water	Bottom	Air	Surface Water	Bottom	Air	Surface Water	Bottom														
Wednesday	13	32	40	42	82	46	46	52	44	44	3 ft.	S.	W.	S.	W.	S.	W.	Clear	Clear	Low	5881			*Had one Sal-
Thursday	14	20	38	38	70	42	42	58	40	40	3 ft.	N.	E.	N.	E.	N.	E.	Clear	Clear	Low*	1525		1	mon to hatch out
Friday	15	50	42	42	72	48	48	60	48	48	3 ft.		S.		W.		W.	Cloudy	Clear	Low	673			after being in the
Saturday	16	58	46	46	68	50	50	62	48	48	3 ft.		S.		S.		S.	Clear	Clear	Low†	650			water one day.
Sunday	17	40	48	48	56	48	48	40	48	48	3½ ft.		E.	N.	E.	S.	W.	Cloudy	Clear	High	475		4	†Raining and
Monday	18	30	40	40	42	40	40	42	40	40	3½ ft.		N.		N.		N.	Clear	Clear	High	453		12	storming.
Tuesday	19	30	32	32	40	36	36	36	36	36	3 ft.		N.		N.	N.	E.	Clear	Clear	Low‡	54		2	‡Snowing very
Wednesday	20	30	36	36	50	36	36	42	36	36	3½ ft.	N.	E.	N.	E.	N.	E.	Clear	Clear	Low	350		6	hard.
Thursday	21	32	36	36	62	38	38	46	38	38	3½ ft.		E.		E.	S.	E.	Cloudy	Clear	High	271		5	River rising
Friday	22	32	38	38	66	38	38	50	38	38	3½ ft.		S.		S.		S.	Clear	Clear	High	243		7	very fast.
Saturday	23	30	35	35	52	35	35	38	35	35	3½ ft.	N.	E.		W.		W.	Cloudy	Clear	High§	295		18	§Still continues
Sunday	24	32	35	35	36	35	35	36	35	35	3½ ft.	N.	W.	N	W.	N.	W.	Cloudy	Clear	High	305		22	to snow.
Monday	25	24	35	35	48	35	35	38	35	35	3½ ft.		N.		N.		N.	Clear	Clear	High	175	2	20	*River up very
Tuesday	26	35	35	35	48	35	35	48	35	35	3½ ft.	N.	E.	N.	E.	N.	E.	Cloudy	Clear	High	140		15	high and still in-
Wednesday	27	40	38	38	42	38	38	46	38	38	3½ ft.		S.		S.		S.	Cloudy	Clear	High*	105	3	30	creasing; expect
Thursday	28	40	38	38	44	38	38	42	39	39	3½ ft.		S.		S.	S.	E.	Cloudy	Clear	High	125		290	to have to move
Friday	29	38	40	40	60	44	44	48	44	44	5 ft.	S.	W.	S.	W.	S.	W.	Cloudy	Clear	High	103	7	1203	boxes.

MD. COMMISSION OF FISH AND FISHERIES.

RECORD OF SALMON HATCHING OBSERVATIONS *made at the North Branch, on the Potomac River, from October 30th, 1880, to November 15th, 1880, by E. H. Walke and A. Wroten.*

Date.		Temperature of —											Depth of water at Station.	Wind.				Condition of —		R.	Loss.				
		7 a.m.				12 m.			5 p.m.															
Day of Week	Day of Month	Air	Surface Water	Bottom	Air	Surface Water	Bottom	Air	Surface Water	Bottom			Direction	Direction		Direction		Sky	Water	Tide	Eggs	Fish	Fish Hatched.	Fish Deposited in Local Wat's	Remarks.
Saturday	30	48	44	44	54	44	44	50	44	44	4	ft.	S.	W.		W.		Cloudy	Clear	High	74	9	2,326		
Sunday	31	47	44	44	38	44	44	32	44	44	4	ft.	S. E.	"		"		"	"	"	67	15	10,276		
November																									
Monday	1	28	40	40	44	40	40	34	40	40	5½	ft.	W.	W.		W.		Clear	Clear	High	102	37	25,224		
Tuesday	2	27	38	38	48	38	38	38	40	40	4	ft.	W.	"		"		"	"	"	117	19	5,618		River up so high had to move the boxes for fear of losing them.
Wednesday	3	20	36	36	50	38	38	40	38	38	4	ft.	S. W.	S. W.		S. W.		"	"	"	93	13	7,482		
Thursday	4	42	38	38	58	40	40	48	40	40	4	ft.	S.	S. E.		S. E.		Cloudy	"	"	57	27	15,237		
Friday	5	34	40	40	60	40	40	50	40	40	4	ft.	N. E.	N. E.		N. E.		Clear	"	"	39	19	24,392		
Saturday	6	38	40	40	60	42	42	56	42	42	3	ft.	S.	S.		S. E.		Cloudy	"	Low	72	9	21,371		
Sunday	7	26	38	38	30	38	38	28	38	38	3	ft.	N. W.	N. W.		N. W.		"	"	"	47	10	28,382		
Monday	8	24	38	38	48	38	38	30	38	38	3	ft.	N.	N.		N.		Clear	"	"	36	13	31,673		
Tuesday	9	30	38	38	50	38	38	48	38	38	3	ft.	E.	E.		E.		"	"	"	67	15	8,252		
Wednesday	10	40	38	38	52	38	38	40	38	38	3	ft.	N. E.	N. E.		"		Cloudy	"	"	83	11	6,755		
Thursday	11	46	38	38	58	40	40	48	40	40	3	ft.	N. E.	"		N. E.		"		"	147	27	2,782		
Friday	12	34	38	38	50	38	38	36	38	38	3	ft.	N.	N.		N. W.		Clear	"	"	129	43	2,567	25,000	
Saturday	13	30	36	36	30	32	32	26	32	32	3	ft.	W.	"		N.		Cloudy	"	"	85	15	1,324		Snow 4 inches deep.
Sunday	14	22	26	26	29	32	32	26	28	28	3	ft.	W.	W.		W.		"	"	"	73	11	1,714	30,000	
Monday	15	22	28	28	20	28	28	20	28	28	3	ft.	S. W.	S. W.		S. W.		"	"	"	140	13	1,025	20,000	
																					13,251		198,035		

MD. COMMISSION OF FISH AND FISHERIES.

RECORD OF SALMON HATCHING OBSERVATIONS made at the North Branch, on the Potomac River, from Nov. 16th, 1880, to Nov. 22, 1880, by E. H. Walke.

Date.		Temperature of—										Wind.			Condition of—			Fish	Fish deposited in local waters.	Remarks.
		7 a.m.			12 m.			5 p.m.			Depth of water at station	Direction	Direction	Direction	Sky	Water	Tide (River)			
Day of Week	Day of Month	Air	Surface Water	Bottom	Air	Surface Water	Bottom	Air	Surface Water	Bottom										
Tuesday	16	20	28	28	30	28	28	30	28	28	3 ft.	W.	W.	W.	Cloudy	Clear	Low	3	15,000	
Wednesday	17	22	30	30	32	30	30	30	30	30	3 ft.	S. W.	S. W.	S. W.	"	"	"	7	20,000	
Thursday	18	24	30	30	20	30	30	18	30	30	3 ft.	W.	W.	W.	"	"	"	5	30,000	Snow storm; wind blowing very hard.
Friday	19	10	30	30	24	30	30	20	30	30	3 ft.	"	"	"	Clear	"	"	11	20,000	
Saturday	20	20	30	30	28	30	30	22	30	30	3 ft.	"	"	"	Cloudy	"	"	115	15,000	
Sunday	21	10	30	30	26	30	30	12	30	30	3 ft.	"	N. W.	"	Clear	"	"	125		
Monday	22	10	30	30	22	30	30	16	30	30	3 ft.	"	W.	"	"	"	"	55	22,396	
																		639	197,396	

The experts in fish culture who visited this station during the development of the eggs, pronounced the eggs and young fish in the most healthy condition; and there was a marked differece between the appearance of the fish hatched in these pure cold waters and those hatched in the warmer waters of the hatching-house in Druid Hill Park.

I am convinced that by means of this system of moveable hatching apparatus our streams can be much better stocked with the salmonidæ than by the system hitherto pursued of developing the eggs in hatching-houses and transferring the young fish thence.

Colonel Hughlett, the Commissioner of Fisheries for the Eastern Shore, having received a like number of eggs from the U. S. Commissioner, the resources of the Druid Hill hatching-house were placed at his disposal for their proper care and development, it being also considered that Baltimore was the most convenient point for their distribution to the waters of his district, as the several lines of transportation centre in that city.

Ten thousand young fish of this lot were kindly turned over to me by Col. Hughlett, 5,000 of which were placed in the head waters of the Gunpowder River and the rest in the Patuxent near Savage Station. The few young California salmon hatched at the Druid Hill hatching-house, from eggs received in the fall of 1879 and re-remaining on hand when the report of the operations of that year was submitted, were distributed, as shown in the following table, on January 6, March 9 and 25.

The table also shows the date on which the fish produced from the eggs hatched for Col. Hughlett were turned over to his messenger. The names of the streams stocked and the places at which they were deposited will no doubt appear in Col. Hughlett's report.

RECORD OF DISTRIBUTION OF CALIFORNIA SALMON, from January 6, 1880, to December 17, 1880, by Maryland Fish Commission under Direction of T. B. Ferguson, Commissioner.

Date.	No. of Fish.	Place of Deposit.	Stream Stocked.	Tributary of	Transfer in Charge of
January 6.	8,000	Keyser, W. Va.	Potomac River.	Chesapeake Bay.	Wm. H. Jenkins, jr.
March 9.	1,000	Sandy Spring, Md.	Pond.	Patuxent River.	Ernest Lawford.
" 25.	800	Buckeystown, "	Pond.	Monocacy "	C. S. Simmons.
Nov. 12.	12,000	Wat's East. Shore, "	Thos. Hughlett.	Commissioner.	Thos. Hughlett, jr.
" 13.	12,000	" " " "	"	"	" "
" 15.	18,000	" " " "	"	"	" "
" 17.	18,000	" " " "	"	"	" "
" 19.	18,000	" " " "	"	"	" "
" 23.	18,000	" " " "	"	"	" "
" 26.	12,000	" " " "	"	"	" "
" 29.	10,000	" " " "	"	"	" "
Dec. 1.	18,000	" " " "	"	"	" "
" 3.	10,000	" " " "	"	"	" "
" 16.	5,013	Phœnix, "	Gunpowder River.	Chesapeake Bay.	Wm. H. Jenkins, jr.
" 17.	5,014	Savage, "	Patuxent "	" "	" "
	165,827				

CALIFORNIA BROOK TROUT—*Salmo iridea.*

During the two years preceding the last, a considerable number of the eggs of the brook trout were purchased and hatched out at the Druid Hill hatching establishment, and the young fry distributed to persons who were desirous of stocking their streams with this fish. The means at the disposal of the Commission did not warrant a further expenditure during the year 1880, and we are indebted to the liberality of the U. S. Commissioner for a supply of trout eggs obtained from the trout common to the streams of the Pacific slope. And as this member of the trout family not only grows more rapidly than the eastern species, but attains a larger size, and is found in much warmer waters than those inhabited by its cousin of the Atlantic states, I have deemed it of importance to attempt its introduction into the waters of Maryland.

Several consignments of these eggs received from the U. S. Commission were successfully hatched and were distributed under the same regulations that had been established for the distribution of the *salmo fontinalis.*

The accompanying tabulated statement of the distribution of the California trout will show the waters in which they were placed.

RECORD OF DISTRIBUTION OF CALIFORNIA TROUT *made from April 15, 1880, to August 9th, 1880, by Maryland Fish Commission.*

Day of Month.	Number of Fish.	State.	Place.	Stream.	Tributary of—	Fish Delivered to.
April 15.	500	Md.		Stream	Gwynn's Falls	J. S. Bull.
" 15	300	"	Buckeystown	Pond	Monocacy	Chas. S. Simmons.
" 16	500	"	Patuxent Station	2 Streams	Little Patuxent	J. T. Popplein.
" 17	500	"	Waverly	Stoney Run	Jones Falls	Henry R. Wilson.
" 17	500	"	Catonsville	Pond	Patapsco	L. Keidel.
" 17	500	"	Long Green Branch	Gunp'r River		Washington Shearman.
" 18	500	"	Pikesville	Stream	Gwynn's Falls	T. J. Meyer.
" 19	500	"	Green Spring Valley	Pond	Lake Roland	S. S. Clayton.
" 19	500	"	Carrollton	"	Patapsco	S. W. Wilderson.
" 20	500	"		Rocky Run	Patuxent	G. W. Ridgley.
" 20	500	"	Airy Hill	Stream	Gwynn's Falls	H. W. Graue.
" 20	500	"	Oakland	Pond	Patuxent R.	C. Francis Dixon.
" 20	500	"		Trout Branch	Patuxent	S. P. Easter.
" 21	500	"		Pond	Gwynn's Falls	H. C. Seymour.
" 21	500	"	New Market	Bush Creek	Monocacy	Dr. H. H. Hopkins.
" 21	500	"	Unionville	Pond	Linganore	Wm. G. Wilson.
" 21	500	"	New Market	Bush Creek	Monocacy	Wm. Downey.
" 22	500	"	Wilna	Plum Tree Run	Bush River	Edw. Hollingsworth.
" 22	500	"	Phoenix	Stream	Gt. Gunpowder	W. S. Carroll.
" 22	500	"	Near Phoenix	"	"	Henry H. Carroll.
" 22	500	"	Near Phoenix	"	"	Saml. S. Carroll.
" 26	500	"	Westminster	Pond	Pipe Creek	Samuel Roop.
" 26	500	"	Westminster	"	Patapsco River	Theo. F. Englar.
" 27	500	"	Arlington	Stream	Gunpowder	P. T. George.
" 27	500	"	Dripping Spring	Gunpowder	Patuxent	Jno. W. Quick.
" 27	500	"	Stream			D. R. Howard.
" 28	500	"	Clearspring	Frantz Mill Dam	Potomac	S. M. Reitzell.
" 28	500	"	Bel Air	Stoney Branch	Bush River	Alex. M. Fulford.

RECORD OF DISTRIBUTION OF CALIFORNIA TROUT *made from April 15, 1880, to August 9th, 1880, by Maryland Fish Commissioner*—Continued.

Day of Month.	Number of Fish.	State.	Place.	Stream.	Tributary of—	Fish Delivered to—
April 30.	500		Eden	Pond	Patapsco	Chas. E. Lanver.
May 1.	500		Anacostia, D. C.	"	Anacostia R.	W. Lee White.
" 1.	500		Baltimore	Stream	Patuxent R.	Wm. H. Baldwin.
" 3.	500		Uniontown	Pond	Big Pipe Creek	Theodore Eckard.
" 4.	500		White Hall	"	Gunpowder	Saml. W. Black.
" 4.	500			Stream		George Small.
" 7.	500		Govanstown	"	Back River	Saml. W. Regester.
" 8.	500		Norrisville	McDonald's Run	Deer Creek	Benson Gable.
" 11.	500	Md.	Frederick City	Pond	Potomac	Daniel Mainhart.
" 13.	500	"	Mt. Pleasant	"	Monocacy	Martin Hoke.
" 14.	1,000	U. S.	Fish Commission			J. F. Ellis.
" 15.	500	Md.	Baltimore	Pond	Gunpowder	John T. Streett.
" 17.	500	"	Warren	Gunpowder		Summerfield Baldwin.
" 18.	500	"	Sulphur Spring	Pond	Patapsco	Henry Cragg.
" 18.	500	"	Sykesville	Stream	W. Branch Potomac	Jos. Barlow.
" 18.	2,500	"	Fairview	Bush Run	Conococheague	Jos. C. Herschberger.
" 19.	500	"	Ijamsville	Pond	Monocacy	J. C. Riggs.
" 20.	500	"	Baltimore	Stoney Run	Jones' Falls	Thos. W. Sweeny.
" 21.	500	"	Ellicott City	Stream	Patapsco Falls	E. Scott.
" 21.	500	"	" "		" "	Edward Davis.
" 24.	500	"	York Road	Pond	Gunpowder	Mrs. J. F. C. Talbott.
" 25.	500	"	Greenwood	"	"	John W. Burton.
" 27.	500	"	Sandy Spring P. O.	Stream	Patuxent	George B. Miller.
" 29.	500	"	St. James	Pond	Gunpowder	J. M. Pearce.
" 29.	20,000	U. S.	Fish Commission			J. F. Ellis.
" 29.	5,000	Md.	Rockville	Rock Creek	Potomac	Saml. Robertson.
" 31.	500	"	Barnesville	Pond	Monocacy	F. P. Hays.
June 1.	500	"	Port Deposit	"	Susquehanna	F. S. Everist.

RECORD OF DISTRIBUTION OF CALIFORNIA TROUT *made from April 15, 1880, to August 9th, 1880, by Maryland Fish Commissioner*—Continued.

Day of Month.	Number of Fish.	State.	Place.	Stream.	Tributary of—	Fish Delivered to—
June 1.	500	Md.	Port Deposit	Pond	Susquehanna	Wm. Adams.
" 4.	500	"	Near Monrovia	"	Bennett's Creek	Levi Price.
" 14.	200	"	Dickerson	"	Potomac	Geo. R. Hays.
" 15.	500	"	Ijamsville	"	Bush Creek	J. C. Riggs.
" 24.	500	"		Stream	Western Run	Chas. Long.
" 26.	500	"	Bella Vista	Pond	Gunpowder	Lambert Gittings.
Aug. 9.	180	"	Southside Club, Long	Island		Wm. Hamlen.
	57,180					

The Carp.

The supply of German Carp for 1879, derived from the increase of those which had been deposited with us by the United States Commissioner, enabled us to distribute during that year 6,135 young fish; which were given to such persons only as had ponds suitably prepared for their reception. The extraordinary success which had attended the cultivation of those previously issued having aroused a lively demand for these fish, the few hundred that were on hand at the opening of the year were all distributed by the middle of January—to the great disappointment of a large number of applicants, whose orders we were necessarily compelled to leave unfilled.

The Carp distributed throughout the State of Maryland are mostly of the two kinds known as the "Scale," and the "Leather" (or scaleless) varieties—the latter being the result of careful selection and breeding are held in somewhat higher esteem.

The Scale Carp, however, from which all our stock is derived, were imported by Professor Baird, some years ago, from the best ponds in Europe. They were so carefully selected by his agents, with reference to purity of stock, that they often produce individuals of the "improved," or "Leather," variety—young fish almost entirely destitute of scales being frequently found in the same brood with those holding more closely to the original type.

It is of interest, in this connection, to record the fact that the fish which have been distributed in the United States, as well as those retained in the breeding ponds at Druid Hill Park, and in the government ponds at Washington, have shown a most remarkable annual growth—greatly in excess indeed of what has ever been observed, for a corresponding length of time, in the case of those bred in their native waters.

This phenomenal development may be readily account-

ed for, however, when we consider that the Carp not only find in our waters the greatest abundance of natural food, but that the comparative mildness of our climate permits them to feed through a much more extended portion of each year than is possible in Northern Europe, where long and rigorous winters condemn them to extended periods of hibernation.

The fact of such relative rapidity of growth has at least been clearly established, and affords a new evidence —as gratifying as it was unexpected—of the complete success which has rewarded the efforts of Prof. Baird to introduce this valuable fish into American waters.

Reverting to our narrative of operations for the year 1879, the ponds in Druid Hill Park were drawn early in May, all eels, frogs and fish inimical to the Carp found in them were destroyed, and a number of aquatic plants were set out to serve as food for the fish and as receptacles for their eggs.

On the 7th of the same month the breeding fish were placed in ponds Nos. 3 and 4—thirty-one Leather Carp being deposited in the former, and one hundred and three in the latter. A few Mirror Carp of varying sizes were also placed in pond No. 4, and a few young Carp in pond No. 1—our main dependence being, of course, the adult fish in ponds Nos. 3 and 4. The imported Golden Ides were still kept in pond No. 2.

Immediately after being returned to the ponds the fish commenced to spawn, and it is quite likely that the drawing of the water, and disturbance of the fish so near their spawning time, was so far detrimental to them that the yield for this year was somewhat decreased in consequence. A number of twigs and blades of water grasses on which the fish had deposited their eggs were taken from the large ponds, with the eggs attached, and were placed in the brick ponds adjacent to No. 2, which had been especially prepared with a view to the purposes of artificial breeding. In a few days the

eggs commenced to hatch, and we soon obtained from them a considerable number of young fish. The large breeding ponds—in which the adult fish had been placed—were not disturbed again until late in the fall. During the summer the ponds were greatly depredated on by herring; kingfishers also occasioning us much annoyance, until the Park Commissioners kindly authorized the attendant to shoot these birds, when their ravages were somewhat abated.

As the attendant was necessarily compelled to be absent from the ponds for a considerable time each day, the kingfishers continued their depredations to a troublesome extent, until a plan for their destruction was suggested by Admiral Ammen, which, as it proved effective, I take pleasure in repeating here for the benefit of culturists whose ponds are subject to the raids of these feathered robbers. In accordance with his directions, several poles were placed upright around the edges of the ponds, each pole being armed at the top with a small steel-trap, set with quite a delicate "trip." The kingfishers and other predacious birds when approaching the ponds naturally select these poles to perch upon as affording favorable positions from which to scan the waters and fall upon their prey; they light, of course, upon the trap which springs to the touch, and either captures them or inflicts a fatal wound.

I am satisfied that the number of fish—especially of the Golden Ide—destroyed by these birds, before the war of extermination commenced, was very considerable, the brilliant color of the Ide making them very conspicuous objects in the water, at the same time that their habit of swimming near the surface renders them an easy prey to their enemies.

In order to secure the young Carp for distribution, we commenced to drain the ponds again on the 20th of October, and again freed them of eels, catfish and other enemies which had accumulated during the summer.

The Carp were immediately assorted, the larger ones being returned to the ponds, while those four or five months old were placed in tanks at the hatching house for distribution. Of the latter it was found that we had available for issue twenty-five thousand seven hundred and eighty-five (25,785) Scale Carp; eighteen hundred and sixty (1860) Leather Carp, and eighteen hundred and twenty-five (1825) Mirror Carp, a very large increase over the crop of the preceding year. The distribution was at once commenced and has been continued up to the present time.

The number of fish given to any one person in 1879 was limited to ten pairs, but the greater success which had attended our efforts at propagation during the summer of 1880, enabled me to increase the allotment for that year to twenty-five pairs to each person who applied for them at the hatching house, while a very favorable arrangement made with the "B. & O." and "Adams" Express Companies enabled me to transport the fish at small cost, and thus to distribute twenty pairs each to many persons living at a distance, who desired the fish, but could not conveniently call for them.

The following letter was mailed, prior to the distribution, to many prominent citizens throughout the State; and the attention of the public directed to the subject in various other ways:

MARYLAND FISH COMMISSION,
1327 "M" ST., WASH., D. C., *Nov.* 1, 1880.

Dear Sir:—

The propagation of the imported "Carp" at the breeding ponds in Druid Hill Park has been so successful this seaaon that I hope to be able to make a very large distribution of this most valuable fish to those persons in the State who desire to cultivate them, and I have made arrangements with the "Adams" and "Baltimore and Ohio" Express Companies which will enable

me to supply the wants of applicants much more conveniently than heretofore.

Last season I issued to each applicant twenty (20) fish, but it was necessary for the parties desiring them to send to the hatching-house in Druid Hill Park for their respective quotas. I am happy to announce that I can now send the fish by Express, through the co-operation of the Companies above mentioned, to any of their stations. This arrangement will save applicants much trouble and expense. I would much prefer, however, to issue the fish at the ponds; and, in order to induce those wishing them to *come* for them, will issue *ten* fish, in addition to the usual number supplied, to those who come for them, and who thus relieve us of the necessity of shipping.

The number of fish that will be sent to parties desiring them will be fixed, for the present, at *forty*. The cost of wagoning to the station, express charges and return of the cans to the Druid Hill Hatching House, will be two dollars ($2.00), which amount will be collected by the Express Agent on the delivery of the fish. The parties receiving the fish must be provided with a vessel to which the fish can be transferred on their delivery. The number of transporting cans belonging to the Commission is limited; and there is, of course, an urgent necessity for their prompt return.

I have received the most encouraging accounts of the success which has attended the cultivation of this fish by those who have hitherto been recipients of them; and it bids fair to fill a want which has been much felt in this State. This fish is so admirably adapted for domestic purposes, that every one in the State who has even a small pond, such as is usually devoted to the collection of ice, should prepare it for rearing the carp, which being largely a vegetable feeder can be raised at very little expense, and can be utilized for the consumption of the waste of the kitchen and garden.

I trust that the arrangements which I have made will

enable you and your neighbors to avail yourselves of the advantages presented by the introduction of this fish into the United States by Prof. Baird. Should you or any of your friends desire to have the carp sent, please address me as above.

I am very truly yours,

T. B. FERGUSON,

Commissioner.

In accordance with the arrangement already referred to, the Superintendents of the Express Companies issued the following instructions to their agents:

SUPERINTENDENT'S OFFICE,

BALTIMORE, MD., *Nov.* 1, 1880.

Agent.

"Several shipments of live fish will be made by the Commissioner of Fisheries to parties in the neighborhood of your station. In delivering them to the consignee, you will in no instance issue the vessels in which the fish are sent. The parties receiving the fish must provide vessels for their removal to the ponds.

A blank receipt will be forwarded with each shipment, and you are required to have the same filled up and signed by the consignee, and return the receipt to the Commissioner of Fisheries.

Should the fish not be promptly called for, you are requested by the Commissioner to change the water in the cans once or twice a day, or whenever the fish show signs of distress by coming up and remaining at the top of the water.

If the fish are not delivered within 5 days after their arrival, you will report the fact to this office and await instructions. After delivering the fish return the empty cans as soon as possible to this office, regularly way-billed FREE."

How widespread has been the demand for the Carp

and the extent to which the Commission by satisfying that demand has enabled the people of the State to enter upon the important work of cultivating this valuable fish, may be ascertained in part by a perusal of the following tables, which show only the distribution made under my immediate direction, a large additional number having been turned over to my colleague, Col. Hughlett, for distribution in his neighborhood and not being included in this statement. As the supply of Leather Carp was considerably smaller than that of the Scale Carp, I secured from the U. S. Commission a number of the first named variety; and sixteen hundred (1600) of these, as well as two thousand Scale Carp from the ponds at Druid Hill Park, were turned over to Col. Hughlett to supply the wants of those who had applied directly to him:

RECORD OF DISTRIBUTION OF GERMAN CARP made from Jan'y 7th, 1880, to Dec. 28th, 1880, by Maryland Fish Commission, under direction of T. B. Ferguson, Commissioner.

Date.	No. of Fish Originally Taken.	State.	Place.	Stream.	Tributary of	Fish Delivered To
January 7	20	Md.	Glencoe	Pond	Gunpowder	Jos. W. Mowell
" 8	20	"	Baltimore	Lake	Stony Run	Thos. W. Levering
" 8	20	"	New Market	Pond	Bush Creek	Mrs. E. C. Shipley
" 8	20	"	" "	"	Linganore	John Burgess
" 8	20	"	" "	"	"	J. W. Dorsey
" 8	20	"	" "	"	Bush Creek	W. M. Downey
" 8	20	"	" "	"	Linganore	Dr. J. W. Downey
" 8	20	"	" "	"	"	John D. Shearer
" 8	20	"	" "	"	Bush Creek	Howard H. Hopkins
" 12	20	"	North Branch	"	Patapsco	William M. Baker
" 12	20	"	Spencerville	"	Potomac	Charles Righter
" 16	20	"	Westminster	"	Pipe Creek	Dr. Herring
" 16	20	"	Fountain Val	"	"	Fred. Zahn
" 16	20	"	" "	"	"	John Wolf
" 16	50	"	Frederick City	Monterin Lake	Monocacy	Charles J. Lewis
" 28	20	"	Baltimore	Pond	Patapsco	Felix McCurley
" 30	20	"	Bel Air	"	Winter's Run	P. Howard
February 7	20	"	Aberdeen	"	Swan Creek	John H. Orem
" 10	20	"	Harford Co.	"	Long Green	John T. Street
" 10	20	"	Trappe	"	Choptank	Jas. W. Long
" 10	20	"	Baltimore	"	Little Gunpowder	Ann Emory
" 11	20	"	Druid Hill Park	"	Jones' Falls	M. C. Barclay
May 6	20	"	Catonsville	"	Patapsco	L. Keidel
" 6	20	"	Long Green Val.	"	Big Gunpowder	Edw. F. Jenkins
" 7	20	"	Bel Air	"	Bush River	G. L. Van Bibber
" 7	20	"	" "	"	Bynim's Run	John Clayman
" 7	20	"	" "	"	Bush River	S. Archer
" 7	20	"	" "	"	Winter's Run	E. H. Webster

RECORD OF DISTRIBUTION OF GERMAN CARP made from Jan'y 7th, 1880, to Dec. 28th, 1880, by Maryland Fish Commission, under direction of T. B. Ferguson, Commissioner.—Continued.

DATE.	No. of Fish Originally Taken.	State.	Place.	Stream.	Tributary of	Fish Delivered To
May 7	20	Md.	Bel Air	Pond	Winter's Run	P. Donnegan
" 7	20	"	"	"	Bush River	H. Stump
" 7	20	"	"	"	"	P. Howard
" 7	20	"	"	"	Bynim's Run	Wm. S. Forward
" 7	20	"	"	"	"	John S. Dallam
" 7	20	"	"	"	"	L. Cahn
" 7	20	"	"	"	"	H. W. Archer
" 7	20	"	"	"	"	Geo. Y. Maynadyer
" 7	20	"	"	"	"	Wm. S. Richardson
" 7	20	"	Govanstown	"	Back River	Samuel W. Regester
" 7	20	"	Airy Hill	"	Gwynn's Falls	W. H. Graue
" 7	20	"	Ellicott City	"	Patapsco	W. A. Hammond
" 7	20	"	Jessups	"	Patuxent	A. J. Gall
" 8	20	"	Baltimore	"	Gunpowder	Geo. Appold
" 8	20	"	"	"	"	M. Gill
" 8	20	"	Dayton	"	Patuxent	James Harban
" 10	20	"	Bel Air	"	Bush River	Alex. Fulford
" 10	20	"	"	"	"	Andrew Katzmier
" 10	20	"	"	"	"	Henry Fulford
" 10	20	"	Rossville P. O.	"	Back River	Chas. Trump
" 10	20	"	Carroll Co.	"	Pipe Creek	James Ogle
" 10	20	"	Oakland Mills	"	Patuxent	Jno. W. Quick
" 10	20	"	Caroline Co.	"	Choptank	W. Birkigt
" 11	10	"	Frederick Co.	"	Potomac	Daniel Mainhart
" 12	20	"	"	"	Linganore	Wm. F. Boland
" 12	10	"	Contee's Sta.	"	Patuxent	F. K. Jenkins
" 12	20	"	Brooklandville	"	Jones Falls	Rich. H. Woollen

RECORD OF DISTRIBUTION OF GERMAN CARP made from Jan'y 7th, 1880, to Dec. 28th, 1880, by Maryland Fish Commission, under direction of T. B. Ferguson, Commissioner.—Continued.

DATE.	NO. OF FISH ORIGINALLY TAKEN.	STATE.	PLACE.	STREAM.	TRIBUTARY OF	FISH DELIVERED TO
May 12	10	Md.	Denton	Pond	Choptank	Jas. E. Hignutt
" 13	10	"	Highland	"	Patuxent	S. Hopkins
" 13	10	"	Baltimore	Grantly Brook	Susquehanna	G. W. Small
" 13	10	"	Still Pond	Pond	Still Pond Creek	Geo. R. Parrott
" 15	10	"	Greenwood	"	Gunpowder	Washington Shearman
" 17	10	"	Linden Sta	"		Miss E. A. Calvert
" 17	10	"	"	"		C. B. Calvert
" 18	10	"	Mt. Airy	"	Linganore	J. B. Runkles
" 18	10	"	Baltimore City	"	Gwynn's Falls	H. C. Seymour
" 18	10	"	Sulphur Spring	"	Patapsco	Thos. S. Jeager
" 18	10	"	Woodford	"	W. br. Patapsco	Casper Erck
" 18	10	"	"	"	"	Joseph Barlow
" 19	10	"	Ijamsville	"	Monocacy	C. M. Riggs
" 20	10	"	Baltimore	"	Stoney Run	T. W. Levering
" 20	10	"	Sandy Spring	"	Patuxent	Charles F. Brooke
" 27	10	"	Carroll County	"	Grave Run	Dr. J. Weaver
June 4	10	"	Frederick County	"	Bennett's Creek	Levi Pierce
" 7	10	"	"Athol"	"	Patapsco	R. W. Rasin
" 8	10	"	A. A. County	"	Rhode River	James Boyle
July 22	19	"	Carroll County	"	Gunpowder	George Hoffacker
Oct. 28	50	"	Glencoe	"	"	Joseph W. Mowell
" 30	50	"	Clear Spring	"		E. H. Frantz
" 30	50	"	Forest Hill	"	Deer Creek	Andrew Reynolds
" 30	50	"	"	"	"	R. Tucker
Nov. 1	50	"	Near Waverly	"	Stony Run	Henry R. Wilson
" 2	50	"	Baltimore County	"	Bear Creek	Felix McCurley
" 2	50	"	Ellicott City	"	Patapsco	W. A. Hammond

RECORD OF DISTRIBUTION OF GERMAN CARP, made from Jan'y 7th, 1880, to Dec. 28th, 1880, by Maryland Fish Commission, under direction of T. B Ferguson, Commissioner.—Continued.

Date.	No. of Fish Originally Taken.	State.	Place.	Stream.	Tributary of	Fish Delivered To
Nov. 2	50	Md.	Bel Air	Pond	Bush River	Alex. M. Fulford
" 3	50	"	Elkridge Landing	"	Patapsco	W Mackintosh
" 3	75	W. Va.	Old Sweet Spring	"		O. Beime
" 5	50	Md.	Kome	"	Jones' Falls	William W. Shirley
" 9	50	"	Prince George	"	Bear branch	Thomas R. Coward
" 9	50	"	Baltimore County	"		H. C. Tiesch
" 9	50	"	Cedar Hill	"		J. M. Hawkins
" 9	50	"	Phœnix	"	Big Gunpowder	T. V. Richardson
" 10	50	"	Taylor	"	Little Gunpowder	Dr. E Emory
" 10	50	"	"	"	"	Mrs. Ann Emory
" 10	50	"	Oakland, Balt. Co.	"	Jones' Falls	G. H. Forster
" 10	50	"	Dayton	"	Patuxent	James Harban
" 10	40 L*	"	Frostburg	George's Creek	Potomac	T. G. McCulloh
" 10	50	"	Baltimore County	Pond	Patuxent	H. C. Seymour
" 10	20	"	Harford County	Lake	Susquehanna	G. W. Small
" 10	4	"	"	"	"	G. W. Small. 1 year old
" 10	50	"	Baltimore County	Pond	Jones' Falls	A. J. Ulman
" 10	40 L	"	Gaithersburg	"		E. L. Tschiffely
" 11	40 "	"	Westminster	"		Hon. J. E. Smith
" 11	40 "	"	"	"		Wm. A. McKellup
" 11	50	"	Westminster	"	Little Pipe Creek	F. E. Cunningham
" 11	50	"	Highlands	"	Patuxent	B G. Cissel
" 11	1000	"				Thomas Hughlett, Com'r
" 11	50	"	Still Pond	Pond	Sassafras	J. W. Howard
" 11	50	"	"	"	"	W. B. Harboard
" 11	40 L	"	Oakland	"	L. Yonghiogheney	Dr. J. L. McComas
" 11	40 "	"	Colora	"		A. J. Michener

*Leather Carp.

RECORD OF DISTRIBUTION OF GERMAN CARP, made from Jan'y 7th, 1880, to Dec. 28th, 1880, by Maryland Fish Commission, under direction of T. B. Ferguson, Commissioner —Continued.

Date.	No. of Fish Originally Taken.	State.	Place	Stream.	Tributary of	Fish Delivered To
Nov. 11	50	Md.	McDonogh Inst.	Pond	Gwynn's Falls	Col. Wm. Allan
" 11	50	"	Baltimore County	"	Jones' Falls	Philip Bevann
" 11	50	"	Patuxent Sta.	"	L. Patuxent	J. T. Popplein
" 11	50	"	New Market	"	Haseld Run	Wm. E. Swormly
" 12	50	"	Near Sykesville	"	W. br. Patapsco	Joseph Barlow
" 12	50	"	"	"	"	John T. Ridgely
" 12	50	"	" Reisterstown	"	Patapsco	Col. William Norris
" 12	50	"	Brooklandwood	"	Jones' Falls	J. R. Mordecai
" 12	50	"	West Friendship	"	Middle River	John T. Roston
" 12	50	"	Woodstock	"	Patapsco	Samuel E. Davis
" 12	50	"	Flint Grove	"	Dry Seneca	John F. Fletchall
" 12	50	"	Franklintown	"	Gwynn's Falls	G. G. Page
" 12	50	"	River View	"	Broad Run	G. W. Spates
" 12	50	"	Beallesville	"	L. Monocacy	Leoindas Jones
" 12	20	"	Stoney Castle	"	Broad Run	Benjamin White
" 12	50	"	"	"	"	W. O. Rhodes
" 15	50	"	Frizzleburg	"	Monocacy	Frederick Zahn
" 15	50	"	"	"	"	John U. Zahn
" 15	50	"	"	"	"	S. P. Weaver
" 15	50	"	Westminster	"	"	David Reese
" 15	50	"	"	"	Patapsico	T. F. Englar
" 15	50	"	"	"	Monocacy	Samuel Roop
" 15	50	"	Lutherville	"	Jones' Falls	Andrew Reese
" 15	50	"	Rossville	"	Stemmer's Run	Charles Trump
" 15	50	"	"	"	"	J. Sewell Glenn
" 15	50	"	Frizzleburg	"	Monocacy	J. R. Rinehart
" 15	50	"	Pr. George's Co.	"	Patuxent	Alex. Wolle, Jr.

RECORD OF DISTRIBUTION OF GERMAN CARP, made from Jan'y 7th, 1880, to Dec. 28th, 1880, by Maryland Fish Commission, under direction of T. B. Ferguson, Commissioner.—Continued.

Date.	No. of Fish Originally Taken.	State.	Place.	Stream.	Tributary of	Fish Delivered To
Nov. 16	50	Md.	Up. X Rds, Har. Co	Pond	Winter's Run	Joseph Ashton
" 16	50	"	Sandy Spring	"	Patuxent	Charles F. Brooke
" 16	50	"	Up. X Rds, Har. Co	"	L. Gunpowder	St. Clair Baldwin
" 16	50	"	Up. X Rds, Har. Co	"	L. Gunpowder	Silas Baldwin
" 16	50	"	"	"	"	William Baldwin
" 16	50	"	Sandy Spring	"	Patuxent	H. C. Hallowell
" 16	50	"	Brighton	"	"	Samuel Janney
" 16	50	"	"	"	"	H. T. Lee
" 16	50	"	Lewistown	"	Fishing Creek	George W. Miller
" 16	50	"	Sandy Spring	"	Patuxent	Francis Miller
" 16	50	"	Lewistown	"	Fishing Creek	Lewis E. Miller
" 16	50	"	Sandy Spring	"	Patuxent	Henry H. Miller
" 16	50	"	Spencerville	"	"	Warwick P. Miller
" 16	50	"	Olney	"	Potomac	Robert M. Mackall
" 16	50	"	Sandy Spring	"	"	B. D. Palmer
" 16	50	"	Fork P. O.	"	Gunpowder	W. H. Riddle
" 16	50	"	Spencerville	"	Patuxent	Robert M. Stabler
" 16	50	"	"	"	"	Asa M. Stabler
" 16	50	"	"	"	"	Caleb Stabler
" 17	50	"	Chrome Hill	"	Deer Creek	William Gladden
" 17	50	"	Oakland	"	Jones' Falls	F. L. Ruppert
" 17	500 L	"	Westminster	"	Patapsco	Forest and Stream Club
" 17	500	"	"	"	Potomac	" " "
" 18	50 L	"	Indian Landing	"	Severn	Mrs. P. R. Uhler
" 18	50 "	"	Round Bay	"	"	H. O. Hofman
" 18	50 "	"	Finksburg	"	Beaver Run	George W. Armacost
" 18	50 "	"	Baltimore County	"	Jones' Falls	M. M. Leimkuhler
" 18	50 "	"	Rogers' Sta	"	Gwynn's Falls	C. H. Hoffman

RECORD OF DISTRIBUTION OF GERMAN CARP, made from Jan'y 7th, 1880, to Dec. 28th, 1880, by Maryland Fish Commission, under direction of T. B. Ferguson, Commissioner.—Continued.

Date.	No. of Fish Originally Taken.	State.	Place.	Stream.	Tributary of	Fish Delivered To
Nov. 19	50	Md.	Stonesville	Pond	Bear Branch	Jos. Bankard
" 19	50	"	"	"	"	L. D. Vance
" 19	50	"	Westminster	"	Meadow Branch	Jesse Sullivan
" 19	50	"	Westminster	"	Meadow Branch	Chas. Shaffer
" 19	50	"	"	"	Bear Branch	D. Baumgarden
" 19	50 L	"	Stonersville	"	Patapsco	J. F. Shades
" 19	40 "	"	Denton	"		Jas. Hignutt
" 19	40 "	"	"	"		T. Smith
" 19	40	"	Point of Rocks	"		George Souder
" 19	40	"	" " "	"		Thos. D. Bond
" 19	40	"	Gaithersburg	"	Seneca	Harry D. Cooke
" 19	40	"	Salisbury	"	Wicomico	Humphrey Humphreys
" 19	40	"	Uniontown	"		William H. Hoffmann
" 20	50	"	Farn Hill	"	Gwynn's Falls	J. R. Long
" 22	50	"	Baltimore county	"	Chesapeake Bay	Dr. C. E. Coates
" 22	50	"	" "	"	Gwynn's Falls	P. Schlesinger
" 22	40	"	Denton	"	Choptank	J. W. Kerr.
" 22	40	"	Elkton	"		David Scott
" 24	50	"	Anne Arundel Co.	"	West River	J. Fred. Kremelberg
" 24	50	"	Union Bridge	"	Big Pipe Creek	A. E. Null
" 27	40	"	Johnsville	"		R. R. Buckly
" 27	40	"	Williamsport	"		Jonas Bell
" 27	40	"	Elkton	"		A. W. Mitchell
" 27	40	"	Union Bridge	"		Jas. W. Ogle
" 27	40	"	Frederick	"	Monocacy	Jno. H. Williams
" 27	50	"	Greenwood	"	Gunpowder	Wash. Shermann
" 27	50	"	Upper X Roads	"	"	Jas. D. Ball

RECORD OF DISTRIBUTION OF GERMAN CARP, made from Jan'y 7th, 1880, to Dec. 28th, 1880, by Maryland Fish Commission, under direction of T. B. Ferguson, Commissioner —Continued.

DATE.	NO. OF FISH ORIGINALLY TAKEN.	STATE.	PLACE.	STREAM.	TRIBUTARY OF	FISH DELIVERED TO
Nov. 29	50	Md.	Harrisonville	Pond	Patapsco	W. N. Shirley
" 29	50	"	"	"	"	J. A. Dickerson
" 29	50	"	Elllcott City	"	"	Jno. R. Clarke
" 30	50	"	Westminster	"	Monocacy	Jno. D. Roop
" 30	50	"	"	"	Patapsco	Jeremiah Schaffer
" 30	50	"	"	"	"	H. Haines
" 30	50	"	"	"	"	J. E. Shreve
" 30	50	"	"	"	Pipe Creek	J. Y. Diffenbaugh
Dec. 1	75	"	Walkersville	"	Monocacy	Hugh McAleer
" 1	100	"	Rohrerville	"	Potomac	J. E. Holmes
" 1	75	"	Rowlandsville	"	Octoraro	Jno. M. Rawlings
" 3	50	"	Sweet Air	"	L. Gunpowder	Wm. Bower
" 3	50	"	"	"	"	Dixon Brown
" 4	50	"	Towsontown	"	Western Run	Chas. B. McLean
" 4	50	"	"	"	Jones Falls	C. B. Slingluff
" 4	50	"	Sheppard Asylum	"	" "	E. Hermann
" 4	80	"	Ijamsville	"	Bush Creek	C. M. Riggs
" 4	50	"	Baltimore county	"	Patapsco River	O. R. Benson
" 6	50	"	Upper X Roads	"	L. Gunpowder	Jos. A. Heyghe
" 8	75	"	Kennedyville	"	Chester River	L. C. Justis, Jr.
" 9	50	"	Sappington	"	Towser's Branch	Jos. V. Follansbee
" 10	50	"	Rossville	"	Chesapeake Bay	J. T. Glenn
" 10	50	"	Anne Arundel	"	Magothy	Rev. F. Dalrymple
" 11	50	"	Sunnyside	"	L. Gunpowder	Dr. F. D. Mitchell
" 15	50	"	Dickerson	"	Monocacy	Geo. R. Hays
" 15	50	"	Monocacy	"	"	Otho T. Hays
" 15	50	"	"	"	"	David L. Specht

RECORD OF DISTRIBUTION OF GERMAN CARP, made from Jan'y 7th, 1880, to Dec. 28th, 1880, by Maryland Fish Commission, under direction of T. B. Ferguson, Commissioner.—Continued.

Date.	No. of Fish Originally Taken.	State.	Place.	Stream.	Tributary of	Fish Delivered To
Dec. 17	100	Md.	Rossville	Pond	Back River	Chas. Trump
" 17	75	"		"		S. K. George
" 17	75	"	Mt. Airy	"		A. G. Davis
" 18	150	"	Charlotte Hall	"	Patuxent	Theo. Smoot
" 18	75	"	Harrisonville	"	Patapsco	Jno. S. Miller
" 18	150	"	Charlotte Hall	"	Patuxent	J. E. F. Shane
" 18	150	"	N'r Charlotte Hall	"	"	Fred. Wiley
" 18	150	"	Baltimore county	"	Jones Falls	F. Meyer
" 18	1000	"	For distribution	on	Eastern Shore	Thos. Hughlett, Com'r
" 20	75	"	Point of Rocks			Benj. Moffett
" 20	75	"	Brethedsville			Daniel Wolf
" 24	150	"	Upper X Roads	"	Bush River	Chas. T. Scarff
" 24	100		" " "	"	"	Jno. B. Banister
" 24	75		N'r Union Bridge	"	Sam's Creek	Daniel Rinehart
" 24	75					Miss E. A. Calvert
" 28	100		Berlin	"	Snow Creek	Dr. Wm. Henry
	12768					

Although puplic notice had been given, early in the fall of 1879, that the fish could be had by applying for them at the hatching house, many persons neglected to make application until late in the following spring, when the supply had become exhausted, and much disappointment was experienced in consequence of our inability to meet these tardy demands. Fearing a repetition of this procrastination and that the farmers would again postpone sending for their fish until the last moment, I limited the early distribution, for 1880, to 25 pairs to each applicant; it being considered that, if properly cared for, that number would be adequate to the stocking of a very large extent of pond. As the season advanced, however, and the supply of fish remaining in hand was apparently in excess of what would be required to meet the prospective demand, the number given to each applicant was proportionally increased.

The Carp, as has been before remarked, grow much more rapidly in this country than in Europe, and it is quite likely that the fish issued during the winter of 1880 will spawn during the summer of 1882. If this should prove to be the case and the young fish thrive as well as there is every reason to expect they will do, it will not be very long before they will become plentiful in numbers in all the waters of the State.

As an indication of the success which has attended their cultivation in all parts of the United States, I make the following extracts from reports made by those who have received them:

KOSSE, LIMESTONE CO., TEXAS, *June* 28th, 1880.

Dear Sir :—

The German Carp sent Sam'l Bell and me last fall are doing as finely as any one could possibly ask. When they arrived there was very little water in our pond, so we put them in a well with about four feet of water in it, and connected the well with the tank by means of a

small ditch, letting the tank water fill it up; the ditch was left open so that the water would not stagnate. We put five of them in the tank (or pond), and fed all of them on corn bread and vegetables that had seed, such as tomatoes, squashes, etc., all of which they ate. They seemed to like the squash best and preferred it baked. * * * * They are now about four inches wide and a foot long. Corn bread is their favorite diet, and by feeding them at the same place every day they become accustomed to look for it, and now all we have to do when we wish to look at them is to tie a piece of stale bread to a string and float it on the water, when they come up all around it and scramble for it as hogs do for corn. There are numerous parties in this neighborhood with good ponds who want to know whether they can get any this summer or fall. Please let me know at once as fish in this section are scarce and high, and the Carp seems to be *the* fish.

Yours truly, VOLNEY METCALF.

RIXFORD, FLA., *Aug.* 5, 1880.

Dear Sir:—

It will doubtless be a pleasure to you to learn that the Carp you furnished me with last November are doing finely. I ascertained on my return from Savannah with them, that my pond was not ready for their reception, owing to the fact that there were many more black-bass in it than I had supposed. I accordingly confined the Carp in a pen at the side of the pond, giving them water through holes in the side, covered with wire netting. A few weeks since I discovered that a portion of the netting had been displaced and some of them had escaped into the pond, and I then concluded to let them all into it, as I had nearly all the bass out. Their growth since that time has been simply marvelous.

Sincerely yours, GEO. C. RIXFORD.

HOWARD COUNTY., MD., *Oct. 9th*, 1880.

Dear Sir :—

* * * * I received from your assistant, at Druid Hill Park, ten of the Scale Carp in May last. They were then about three inches long, and in digging the pond larger in August, (3 mos. afterward,) I let the water off to catch them and put them in the smaller pond, when I was surprised to find them from seven to ten inches long.

I have no other fish in the pond, and as the ten have done so well would like very much to get some of the Smooth ones. * * * *

Yours truly, JOSEPH BARLOW.

COLUMBIA, S. C., *Oct.* 18, 1880.

Dear Sir :—

* * * * I have the most encouraging reports of the Carp distributed last November; some are ten inches in length and weigh one pound.

A. P. BUTLER,
Comr. of Agriculture.

THE FISH COMMISSIONERS,
ROMNEY, W. VA., *Oct.* 29, 1880.

Dear Sir :—

I have been extremely anxious to secure some more Carp. It is the only fish in which our people seem to take interest, and affords speedy evidence of the importance of our work. Of those received last fall we retained twenty-six in the hatchery ponds. Have them all yet, some weighing considerably over a pound. I am, therefore, very thankful for your offer to let me have more, and write to inquire where I shall send for them. * * * *

Very truly yours, C. S. WHITE.

BEL AIR, HARFORD CO., MD., *Nov.* 1, 1880.

My Dear Sir :—

Through your kindness I received a few Carp from

Druid Hill hatching house the first of last May. At that time the fish were about three inches long and weighed about ½ oz. each. I caught some for our Agricultural Show on the 11th of October (last month). One of them weighed 2¼ lbs. All weighed 2 lbs. or more, and averaged over fifteen inches long. They have had no attention whatever. The pond is about half an acre or more, from one foot to six feet deep. Five of the fish taken from the pond looked so well developed that I think they will spawn next February, although you informed me that they would not spawn until they were two years old. * * * *

Yours truly, JOHN S. DALLAM.

RIXFORD, FLA., *Nov.* 1.

My Dear Sir :—

* * * * My Carp (which are of the Scale variety) continue to thrive splendidly, and are a marvel to all who see them—especially those who saw them when I first procured them in November last when they were only about three inches long—and who now compare them. Many of them are from fifteen to seventeen inches in length, and six to seven inches in breadth. They show no signs as yet of going into winter quarters, coming for their food regularly, and I hope to be successful in carrying them through the cool weather without their resulting to the old habit. * * * *

GEO. C. RIXFORD.

ROSSVILLE, MD., *Nov.* 3, 1880.

Dear Sir :—

Your esteemed favor received. I availed myself of your order last spring to get from the Fish House twenty (20) Carp. They are doing well and have grown finely. From their appearance they must be ten inches in length, and I will certainly procure my quota from the same place at the earliest opportunity. * * * *

Truly and respectfully yours, C. TRUMP.

GERMAN CARP IN TENNESSEE.

NASHVILLE, *Nov.* 25, 1880.

* * * *

The Carp distributed here last year are all doing remarkably well, but those entrusted to Dr. Callender, Superintendent of the Insane Asylum, have made phenomenal progress. When placed in the ponds of the Asylum grounds the fry did not exceed one and a-half inches in length, and they looked very puny. The other day he brought into town five of the smallest he could catch in order to show Col. Akers. These would weigh one and a-half pounds, and livelier or finer looking fish could not be seen. The Doctor could not say definitely if any of them had spawned this year, though, judging from their present condition, they certainly will next spring. Every care has been given, feeding regularly and not allowing any one to disturb them. They have become so tame as to come at call to be fed.

* * * * FOREST & STREAM.

J. H. D.

HOLLY SPRINGS, MISS., *Dec.* 4, 1880.

Dear Sir:—

* * * * One party to whom we gave some Carp last February put them in a small highland horse pond, and about a month ago took one out, which, he says, weighed over three pounds. Have not examined any other ponds stocked at that time, but will do so next spring. * * * *

Yours truly, WALLACE & McGOWAN.

ASTOUNDING GROWTH OF CARP.

It is a fact, that the Carp has grown faster in America than it does in its original home; but the most wonderful story comes from Georgia. A gentleman in Macon sends Prof. Baird the following slip, from a local paper, and vouches for its truth. It says: "Yesterday afternoon

Mr. E. Witkowsky, who owns the tan-yard on the old Confederate armory property, concluded to cut the dam and clean out the pond in order that he might introduce his new German Carp. The pond contained a large number of smaller fish, and among them Mr. Witkowsky hoped to find his four Carp, which had been put into the pond last May. He found three of the fish; but to his astonishment they were by actual measurement twenty, twenty-two and twenty-five inches in length respectively. The fourth escaped through the cut in the dam. These Carp were but two or three inches long when put in the pond, and their growth is remarkable." * * * *

FOREST & STREAM, *Dec.* 9, 1880.

ILLINOIS STATE FISH COMMISSION,
QUINCY, ILL., *Dec.* 14, 1880.

Dear Sir :—

* * * * During the high water of last summer a few of our Scaled Carp escaped from the pond into a little overflow near. I secured them again about ten days ago. One of them measured twelve and one half inches in length. * * * *

Yours truly, S. P. BARTLETT.

SPENCER, OWEN CO., IND., *Dec.* 26, 1880.

My Dear Sir :—

* * * * My five Carp went into winter quarters about Nov. 10th. I estimate their weight at that time at two and a quarter pounds. I regret I was not able to get some of your fall distribution. * * * *

With respect, C. FLETCHER.

"To one who has never witnessed such a thing before, it is an interesting sight to see fish assemble for their feed at the sound of a horn. Arthur O'Keefe has his lake stocked with the rare and valuable fish known as the German Carp, and the writer being on hand a few

days ago was asked to step down to the lake and see the fish fed. Mr. O'Keefe's little boy, Johnny, gave a few blasts with a tin horn; a handful of bread was scattered in the water, and the Carp appeared by the hundreds, eagerly seizing the bits of biscuit. This fish is quite gentle, seeming to care but little for our presence, and even coming slyly up to nibble at a biscuit held in the hand. Most of those which we saw were about five inches in length, though there are many both larger and smaller in the lake." * * * *

RANCOCAS STOCK FARM,
JOBSTOWN, BURLINGTON CO., N. J.,
January 10, 1881.

Dear Sir :—

Enclosed please find receipt for the thirty-three Carp sent me in the spring of 1879.

We put them in a pond of about four acres, about nine feet deep in the middle, muddy bottom. We did not see much of the fish during 1879, but this spring they appeared by millions. You cannot go anywhere around the pond and throw in a few crumbs of bread, but they would rise in clouds for it, from a little one just hatched to a fish 4 and 5 inches long. We gave them this season lettuce, cabbage and other vegetable matter; also bread crumbs and boiled hominy. The larger fish—those that were put in for stock—we rarely see; once in a while one will jump out of the water. I should judge that last fall they were about 10 inches long. They appear to remain closer to the bottom of pond than the small ones. Had much difficulty in killing off the snapping turtles, and large bull-frogs, with which the pond was filled. We found the large frogs would eat the fish. There are now enough for all men and reptiles. We cut holes in the ice on pond, and stick in a bundle of straw, for ventilation. This is the plan I am told they do in Germany.

Respectfully yours, P. LORILLARD.
J. W. GRISWOLD, *Agent.*

MELLENVILLE, *January* 10, 1881.

Dear Sir :—

I received thirteen small Carp (the size of my thumb-nail) on the Sunday, 9th of May last, in good order, and immediately emptied them in my pond, which was not quite completed. They were out of sight in an instant; the bottom being ⅔ clay and ⅓ sand, so that it was constantly rolly. Some days after I noticed the pond was full of frogs, some of large size, and as the fish had not been seen I supposed they had destroyed them. I called upon Mr. Blackford, in N. Y., soon after, but he could give me no information. In the latter part of August, the season being very dry, I had the water let out of the pond, and set workmen to finish digging it out with horses and scrapers. After they had been at work several days, three dead carp were seen that had been hurt with the horses; one of which I measured and was 10 inches long, and weighed over a pound. We then saw 9 remaining in the water that was but about 12 inches deep, in a small space in the centre of the pond, which we fed with crumbs of bread until the cold weather set in (in November), and the pond froze over with not more than 18 inches of water. When our work was complete, about Sept. first, I found my spring that had never been known to give out before, was so near dry as to give us but a small quantity of water, and I fear the ice has frozen so hard and tight that the fish will smother. The wonderful growth from 9th of May to 9th September—say 4 months—beats anything I ever saw or heard of.

I had intended to make report to you before, but did not want to report a failure. On the 23d of last September I was in Washington, and called at your residence to make my report in person and pay my respects, and was told you were out of town. I shall be pleased to be enabled to report favorably next spring, or as soon as the ic gives out.

Respectfully, DANIEL BIDWELL.

GROWTH OF CARP IN VIRGINIA.

GORDONSVILLE, VA., *February* 4, 1881.

COL. M. MCDONALD,

Commissioner of Fisheries for the State of Virginia.

Dear Sir :—

The seventeen Carp which you gave me in the fall of 1879 are doing remarkably well. In October last I caught four of them to see what growth they had made. They weighed from two and three-quarters to nearly four pounds. The largest one only lacked about two or three ounces of weighing four pounds. I am satisfied that they are just the fish for the waters of Virginia, and am sure they are the only fish suited to our ponds. General Field put 25 Carp in my pond some time since, which I understand were intended for my brother who has lately built a very nice pond. I was not at home at the time and suppose General Field thought they were intended for me. I take great interest in the fish-culture, and am satisfied you are doing a very great good by distributing the young fish in the waters of Virginia. Wishing you great success and thanking you for your kindness, I am, yours, very truly,

H. C. BAKER.

MT. MORRIS, GREENE CO., PA., *Feb.* 15, 1881.

PROFESSOR SPENCER F. BAIRD.

Dear Sir :—

It will doubtless give you pleasure to learn that the ten Mirror Carp I got of you the first of last June are doing finely and their growth is wonderful. When I received them, they were from four to five inches in length, and when last seen I believe them to be fifteen to eighteen inches long. I failed to learn the sex when I was at Washington. I received your order late last fall for some fish at Pittsburg. At that time I was very low with inflammatory rheumatism, and failed to get them. I want to construct another pond of one acre, provided I

can get the fish of you to stock it. I want the Scale or Leather Carp; also a few Mirror Carp for the old pond. I shall await your answer before commencing my new pond. Hope to hear from you soon.

Yours truly, J. W. LONG.

EXTRACT FROM CIRCULAR 48 RETURNED BY JAMES G. FIELD, GORDONSVILLE, ORANGE CO., VA.

In the fall of 1879 I obtained from Col. McDonald of your office thirty-two German Carp. Sixteen of them were put in Mr. Baker's pond and sixteen in the pond of my mother-in-law, of which I have control. Last fall Mr. Baker found that his fish had developed very rapidly. He succeeded in catching three or four and found them to weigh from 1 to 3 lbs. Last month my daughter and a friend were fishing in the pond of my mother-in-law and caught one that weighed four pounds. Last spring I received from Col. McDonald a lot of the "Leather Carp," but I cannot report as to their development to the present time. Next month I will get a seine and make a full inspection of the ponds of Mr. Baker and of my own, and will, if you desire it, report fully the result. I should like very much to have copy of any book or books you publish, and if I can render any service to you, will most cheerfully do it. If you will pardon the suggestion, I will say, that I think the *small fry* you distribute should only be given to persons who have private ponds, and who will agree that when the fish are grown they will turn them into adjacent streams. The fish you send out, if put directly into streams and large ponds full of Chub fish, Perch, Cat, &c., will all be destroyed before they have sufficient size and strength to protect themselves or escape their enemies.

May 16th, 1881. JAMES G. FIELD.

The results of the experiments of the last two or three years have shown, conclusively, that the waters of

Maryland are admirably adapted to the cultivation of the Carp, and it may, therefore, be confidently expected that within a comparatively short time every farmer throughout the State will have one or more fish ponds, which will prove quite as much a source of pleasure and profit as is the familiar chicken-coop or pig-pen.

Although hitherto regarded as being essentially a fresh-water fish, it is quite likely that the Carp will thrive in brackish water as well. I would, therefore, earnestly recommend to those of our citizens whose surroundings prevent them from securing ponds of entirely fresh water, that they try, at least, the experiment of cultivating this fish in such water as they are able to control. It should also be borne in mind that the Carp is peculiarly well adapted to waters which are subject to very high degrees of temperature during the summer months; for, although it sturdily withstands the rigors of a Northern winter, it is even more at home in a warm climate: and the most favorable results have attended its introduction into our extreme Southern States.

As much of the success attainable in Carp culture must always largely depend upon the character of the ponds, and of the water with which they are supplied, proper care must of course be exercised in each case to obtain as favorable conditions as possible.

It is important in the first place that the ponds should have soft, muddy bottoms; and that they be furnished in the second place with aquatic plants—especially those producing seeds which will fall into the water when ripe. The Carp spawns in the spring and summer—often extending its breeding season into the fall months—and as the eggs upon being freed from the body of the fish attach themselves to the plants where they remain exposed to the attacks of other fish, by whom they are greedily devoured, no fish besides the Carp should be allowed in the ponds reserved for breeding purposes. The young fish, it should be remarked, usually make

their appearance in from three or four to fourteen days, according to the temperature of the water.

CONSTRUCTION OF THE PONDS.

While it is certain that the cultivation of the Carp is of sufficient importance to the farmers to fully warrant the construction of ponds for the express purposes of such cultivation, it is also true that there already exist in many places—and more particularly in the southern and south-eastern portions of the State—numbers of ponds such as are now used for the collection of ice, or for supplying water to live stock during the summer could be readily converted into productive Carp ponds at a comparatively small cost. There are also many depressions of surface in the lands bordering upon some of our larger rivers, especially in the tidal region, which could be reclaimed and filled with water with but little labor, and made to answer admirably for the same purpose.

It is very desirable, on several accounts, that the ponds which are to be devoted to the cultivation of this fish should be so constructed as to permit all the water in them to be drawn off at certain intervals. By this means the fish can be readily captured and assorted without injury; when those intended for breeding purposes should be restored to the pond, and the remainder placed in tanks from which to be subsequently taken, by the aid of dip-nets or small seines, as required for market or for home consumption. The advantages of this facility of drawing off the water will be further experienced whenever the necessity arises for destroying such enemies of the fish as may succeed in effecting a lodgment in their midst.

In the case of such ponds as are supplied by the inflow of tide-water, for instance, the eggs of native fishes are often wafted in, and the fish thus produced soon commence to consume the food, and even the eggs and the young, of the Carp. By draining off the ponds once or

Spring
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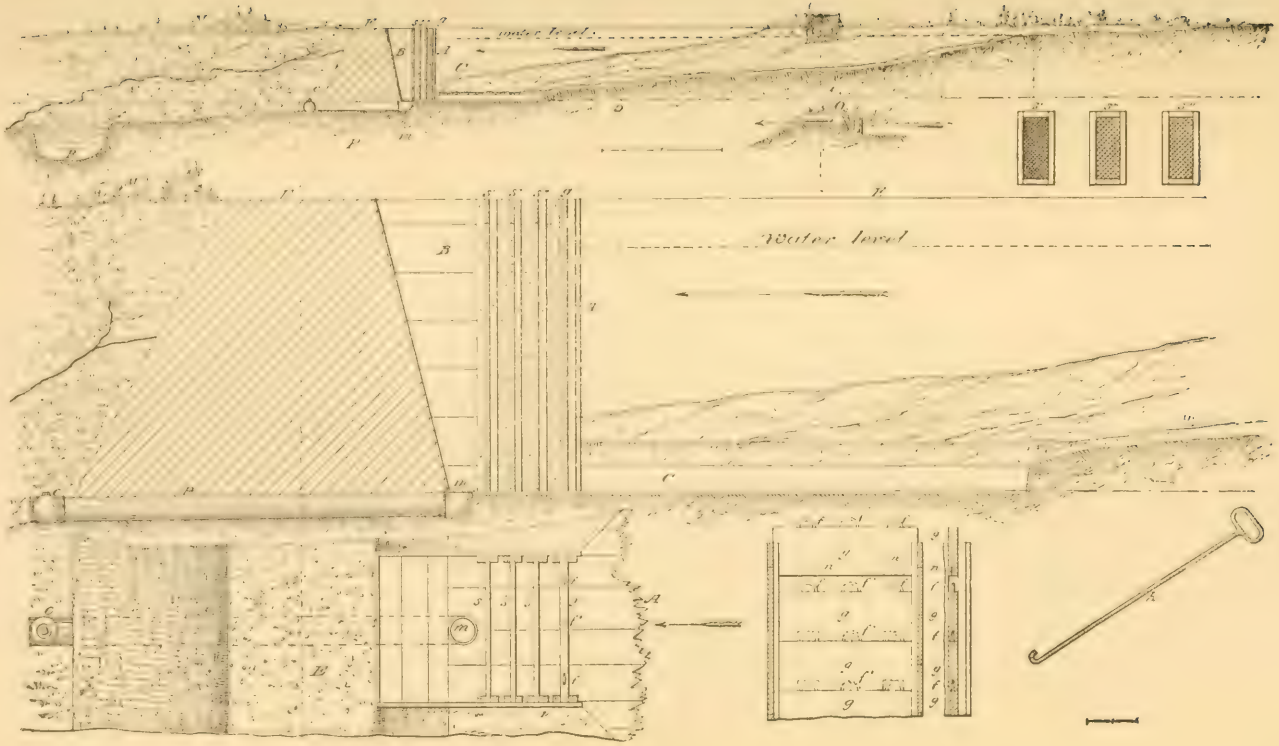

Water level

twice a year however, these intruders can be readily removed and destroyed; and the fish which are the objects of the farmer's special care be allowed to exist and multiply unmolested.

When the utilization of an ordinary ice-pond for Carp culture is contemplated, the essential points to be regarded are so simple that it is only necessary to suggest them in order to the guidance of the most inexperienced culturist. In the preparation of ponds of this character it is not necessary that the drainage from the surrounding fields should be diverted, except when excessive in quantity or liable to become so after a heavy fall of rain. A certain amount of such drainage, indeed, often proves beneficial, as considerable quantities of food, generally of a very desirable nature, are thus conveyed into the ponds; in the event of its being admitted, however, an "overflow" must be provided, which should be well protected by wire-cloth screens to prevent the escape of the fish. As this overflow constitutes the most important feature to be regarded in the construction of a pond, it is necessary that it be first and carefully considered.

For the purposes of illustration, there are shown in the accompanying plates the details of a pond which is supposed to be located in a meadow, through which flows a rivulet or small stream; and formed upon two sides, by embankments of earth obtained by the removal of a portion of the soil from the enclosed space. The water may be supplied either by introducing it from the rivulet itself, at some higher point; or, as in this illustration, from a spring in the adjacent meadow, supplemented by the surface drainage from the surrounding high land.

A small tributary of the rivulet is utilized in this instance to carry off the surplus water which is allowed to escape from the pond through the overflow indicated at the point *O*.

A, shows the apparatus for emptying the pond; the

details of which will be given in another connection.

B, indicates a frame, enclosing the end of the discharge pipe leading from the pond; and provided with screens, *s. s. s.*, the purpose of which will be indicated hereafter.

C, is the "collector," into which the fish are drawn by the lowering of the water in the pond; and *c* a valve, which controls the flow of the water through the discharge pipe, *m*.

D, indicates the position and direction of a wide, shallow drain at the bottom of the pond; having smaller drains, *d. d. d. d.*, by means of which all of the water is led into the collector when the pond is being emptied.

E, represents the embankments; which are about six feet in height at the angle of the pond, the lowest part of the meadow gradually lessening with the ascent of the land until they are lost in the higher ground.

In the next plate the upper portion presents a longitudinal section of the pond. The lower part of the plate shows a portion of the same section enlarged, so that with the horizontal projections the position and detail arrangements of the pond are clearly illustrated. The fish are readily drawn into the collector *C*. A long handle hook for removing the planks *g*, *g. g*, is shown at *h*.

As already stated, the "overflow," indicated at *O*, is perhaps the most important point to be considered, and especial attention is therefore directed to its construction. By way of precaution this outlet is located in the solid ground at the side of the pond, rather than in any part of the embankment, which might be weakened by its presence; and is protected by three wire-cloth screens of varying texture, the coarser mesh being placed farthest in the pond in order to collect all drift, and thus prevent the clogging of the second and third screens, the meshes of which should be fine enough to preclude the escape of the smallest fish. It will also be observed that the screens are so placed as to present a considerable

surface below the water level—the purpose being to insure them against being clogged by the piling up of successive layers of drift, which otherwise would inevitably be occasioned by the gradual rise of the water consequent upon its obstructed flow. The arrangement suggested will always afford a free exit to the water beneath the mass of accumulated floating rubbish.

The general details of outlet, *A*, are clearly indicated in the views given. The screens *s. s. s.*—as well as those of the "overflow"—are disposed in a suitable frame work, and should slide easily in their respective grooves, so that they may be readily removed, cleaned and replaced. An additional set of such grooves are provided at this outlet, as will be seen by reference to the plate; and these latter, which are innermost in point of position, are furnished, instead of screens, with solid planks *g. g. g.*—the edges of which are neatly fitted to each other, so as to render their joints water tight, or as nearly so as possible. The upper edge of each plank, again is provided with staples or eyes—*f. f. f.*—through which the hook, *h*, may be readily passed in order to lift the plank from the frame. When the planks are in position these eyes are received into corresponding slots, *n. n.*, in the lower edge of the planks immediately above them, so as to allow the planks to fit closely together.

The purpose of this fourth, and *solid*, screen is to enable the culturist to lower the water in the pond, whenever it becomes necessary to do so, by drawing it from either the surface or the bottom, as may be deemed most advisable. To draw it from the surface only, it will simply be necessary to open the valve *c*; and to remove the planks in succession, as the water subsides. While to draw from the bottom will require all the planks to be first removed; and the valve to be opened when this has been done.

In addition to the valve *c.*, the drain-pipe, *P*, may be provided, at *m.*, with a clog or strainer, to guard it

against the accumulation of sediment or other obstructive matter.

The collector, *C*, as is shown in the plates, should be placed at the lowest point in the pond; and, unless excavated in very hard clay soil, should be both floored and faced with plank, cement or other hard material. The Carp, it will be remembered, have a strong tendency to bury themselves in the mud not only during their periods of semi-hibernation, but whenever suddenly alarmed or closely pursued: and if the collector has been constructed as suggested, and the fish are gradually drawn into it with the subsiding water, all danger of loss on this account will be obviated.

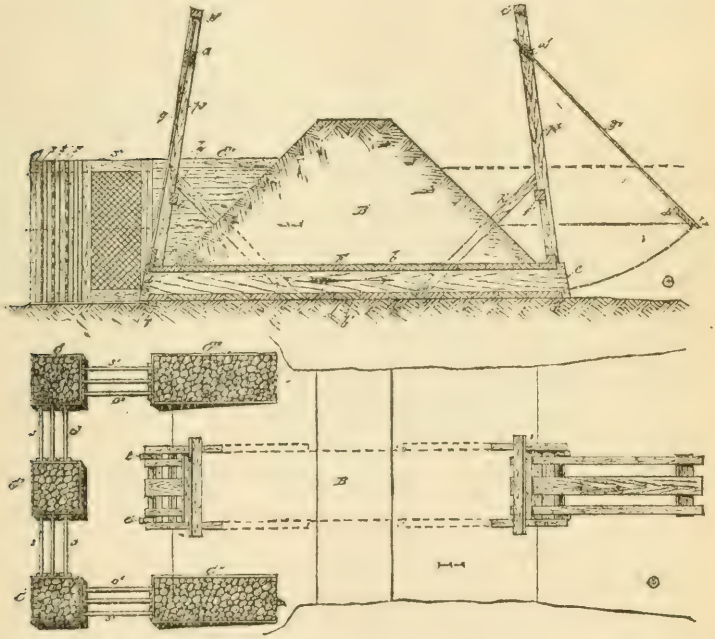
The details of the "overflow," "outlet," "collector," &c., may, of course, be somewhat varied, according to circumstances: but the general requirements of a pond so located as to receive its supply of water at one end, and to discharge it at the other, are believed to be fully answered in the foregoing description.

Ponds in this latitude should be not less than three feet in depth at their deepest part—to insure the fish against being frozen in severely cold weather—and should gradually shoal in places to a depth of one or two inches to provide the shallows required for spawning purposes. Small knolls and islands should be levelled or removed, as they generally afford harboring places for the enemies of fish.

Ponds in Tidal Regions.

It having been remarked in another connection that ponds formed by the reclamation of marshes in tidal regions might also prove well adapted to the cultivation of the Carp, the following suggestions are added with especial reference to the peculiar location of such ponds. The collector and drain ditches should be constructed and arranged in accordance with the instructions already given—the collector being formed, of course, at the lowest point within the embankment.

The "overflow" may be omitted, if desired, as the "flume" can be readily adapted to the purposes of carrying off any surplus water. As the flume, however, requires constant attention to insure its operation, the "overflow" should be retained, if practicable, in which event it is of even greater importance than in the case of the ponds already described that it should be placed in firm ground.



The accompanying diagrams represent a vertical section, and corresponding horizontal projection of the embankment, *B*—showing the position of the flume, *F*, and its controlling valves, *d, d;* together with that of the crib-work, "*C, C, C,*" which is constructed on the pond side, and is designed to support the screens employed to prevent the escape of the Carp and the ingress of other fish.

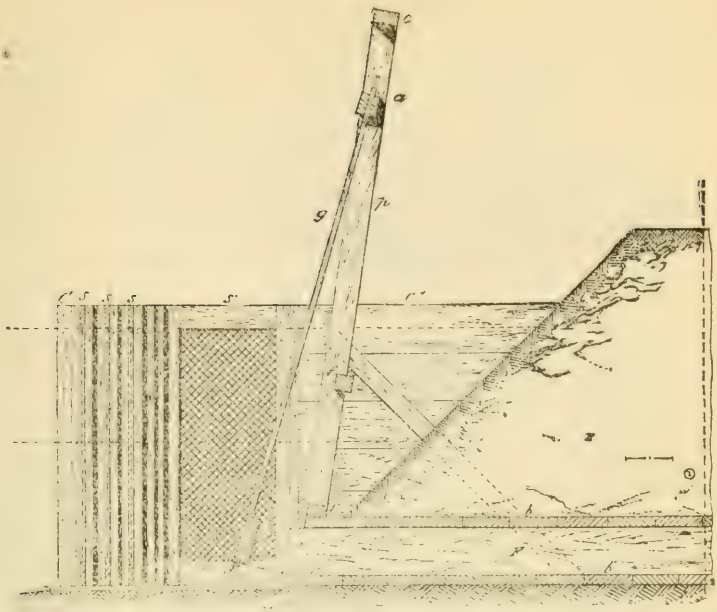
The flume is placed, as before, on a level with the bot-

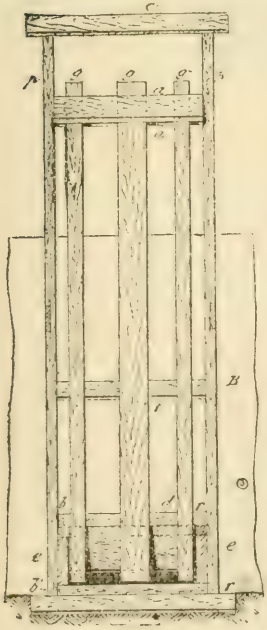
tom of the collector, and the valves are here shown as they appear when arranged for drawing the water *from* the pond, at ebb tide. The inner valve has been slightly raised, as will be observed, by *sliding* upward its support *g* through the grooved trunnion *a;* and the pressure of the water flowing through the flume, in the direction indicated by the arrow, serves to *swing* open the outer valve, and to keep it open until the pond is emptied or the tide turns. In the latter event the outer valve closes automatically until the level of the water without again falls below that of the water remaining in the pond when its operation is resumed.

Should it be desired, on the other hand, to admit water from the river *into* the pond—at the proper levels—the relative positions and operations of the valves would of course be reversed. The outer valve should then be raised so as to allow the water to enter the flume from the river; and the inner valve should be lowered, in turn, to permit it to swing with the current, and to close automatically with the cessation of its flow.

The accompanying figures represent portions of the above considerably enlarged for the purposes of a more detailed description of the several parts.

The flap valve *d*—which is here represented as being

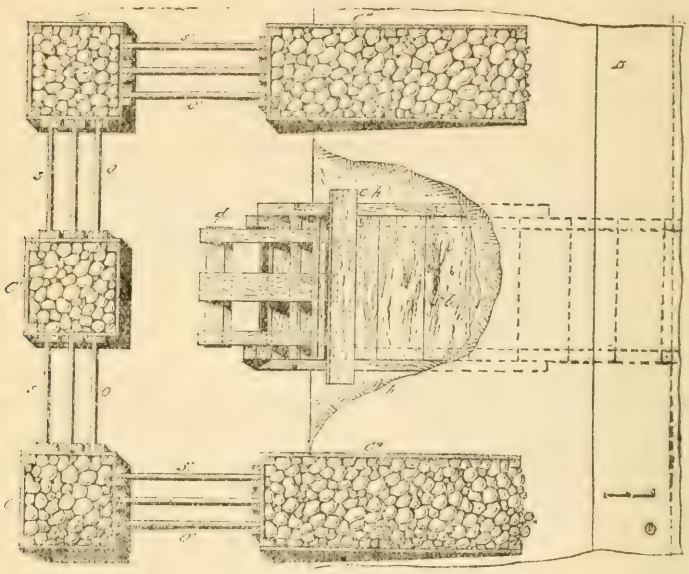




forced slightly open by the presence of the inflowing current—is attached to the lower extremities of the long strips or pieces, *g g*, *g*, arranged to slide upward through mortices in the beam, *a*. The latter, in turn, is provided at each end with trunnions fitting loosely into corresponding sockets in the uprights *p*, *p*, by which means the beam and its dependent parts are allowed to swing readily in place, as indicated by the positions of the gate or valve in the several diagrams.

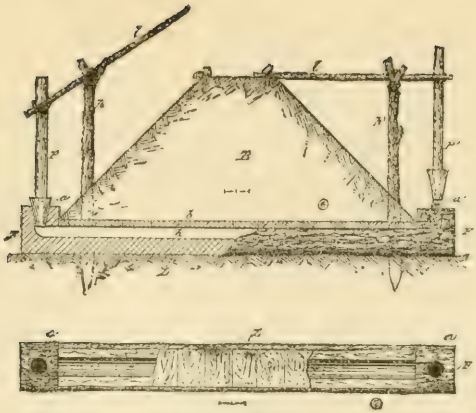
Another and fixed beam, indicated at *f*, serves as an additional support to the uprights, *p*, *p*; and as the fulcrum of a lever by means

of which the gate may be raised or lowered. "*C, C, C*" represent crib-work, filled with stones, and sustaining in position the screens *s, s* and *o, o*, which are arranged



to slide in their respective grooves, similarly to those already described.

A flume or trunk of somewhat simpler and cheaper design; which may be constructed by hollowing out one side of a stout log, for nearly its entire length, and covering the groove thus formed with pieces of thick plank, is also figured; the bark should be allowed to remain undisturbed, where practicable, for the sake of the protection which it affords to the wood. The general arrangement of the flume and its valves is so plainly indicated in the diagram as to render further description unnecessary; it will only be remarked, therefore, that as the valves do not work automatically, such a "plug-trunk"—as it is called—would appear to be better adapted for ponds located in other than tidal regions.



So much of the wood work, in all these constructions, as may be exposed to the air, and, particularly, such parts as are subject to the alternate action of the air and water, are liable to more or less rapid decay, and should be protected by thick coatings of paint, or other preservative material. Such other parts as are imbedded in the embankment, however, will be found to last for years.

SUMMARY OF OPERATIONS at Hatching House, Druid Hill Park, for 1880.

Month.	Average temperature at noon of Water.					California Salmon.			Land Lock Salmon.			Trout.			German Carp.								Penobscot Salmon.	
															Scale.		Leather.		Mirror.					
	Air.	Hydrant.	Troughs.	Springs.	Ponds.	Number eggs received.	Number fish or eggs lost.	Number distributed.	Number eggs received.	Number fish or eggs lost.	Number distributed.	Number eggs received.	Number fish or eggs lost.	Number distributed.	Number lost.	Number distributed.	Number lost.	Number distributed.	Number lost.	Number distributed.			Number fish or eggs lost.	Number distributed.
January	43.78	41.55	42.58	52.60	43.03		217	8000	25000	573					6	870						1941	
February	43. 58	41. 10	42. 10	50. 58	43. 44		85			1820		60000	4882	20000‡		100						573	
March	44. 46	44. 43	45. 23	51. 33	46. 55		32	1800		1051	200†	87000	19521	15000‡								1272	26000
April	56. 28	50. 46	51. 40	51. 13	56. 21		416			2932	10500	20000	19829	14300								385	32729
May	71. 72	60. 48	71. 06	54. 58	71. 93		3632			6401	6200		27358	39500	52	800							§
June	75. 76	70. 83	70. 56	59. 85	76. 99		153			83			1606	3200	2	30							
July	78. 88	76. 42	76. 36	61. 20	80. 41		28			20			1750		1	19							
August	76. 48	75. 16	74. 87	61. 00	77. 31					11			129	180									
September	70. 87	71. 35	71. 35	60. 38	71. 15					11													
October	59. 17	61. 18	61. 22	60. 35	59. 93	200000	35916								635	200	60		47				
November	44. 28	47. 16	48. 27	55. 07	47. 88		7263	118000							216	5859	88	1710	95				
December	33. 20	37. 20	37. 50	50. 26	37. 48		528	38027							130	3680			9				
Total						*200000	48270	165827	25000	12902	16900	167000	75075	57180	1042	11558	148	1710	151			4171‖	58729

*Excess over 200,000 caused by number lost and distributed from eggs received in 1879. †1 year old. ‡‡35,000 eggs.

‖From eggs received in 1879. §Pond No. 4 overflowed on 11th, causing a loss of between 2 and 3 thousand young Carp.

*200 Carp to S. G. Worth, N. C. 300 Carp to Washington, by Wm. Hamlen. N. B.—Not embodied in table of Carp Distribution.

Oyster—(*Ostrea virginiana.*)

In my last report submitted to the Legislature on the 1st of January, 1880, I explained how the consideration of the oyster beds and the study of this important mollusk had been forced upon the Commission, as a thorough appreciation of the influences which bear upon the existence or non-existence, the increase or decrease of many of our important fishes, required some investigation as to the state of the oyster beds and the possibilities of employing means of continuing or restoring these beds, should they be destroyed by natural influences or by the too extravagant and wanton use of them.

Whereas the investigation was commenced rather to ascertain the capacities of the oyster-beds for producing food for the more important fishes, the developments have been so important and the prospects so bright of increasing by artificial means not only the number of oysters, but adding to their excellence by careful cultivation, I have prosecuted these researches to the fullest extent that the limited means at my disposal would permit.

It has been with much regret that the important experiments have of necessity been delayed and postponed from time to time, until by the practice of the closest economy in other branches of fish culture in the State a sufficient proportion of the portion of the appropriation assigned to me could be devoted to this purpose.

In consequence of the reduction of the amount available, the experiments have not been made on such a scale and with that thoroughness which I had hoped, nor have they been made as rapidly as their possible importance to the State would seem to demand. Enough has been determined to warrant the prediction that the day is not far distant when oyster culture on the Chesapeake Bay will be one of the most prominent industries of the State.

Besides indicating how the oyster industry can best be fostered and guiding capital in its best investment, I

trust that the accurate knowledge obtained from these investigations may direct legislation on this hitherto very vexed and intricate question.

In our last report we gave at length the article of Prof. W. K. Brooks, whose services had been secured for these biological investigations by the Commission, and we, al through the courtesy of Mr. Carlisle P. Patterson, Superintendent of the Coast & Geodetic Survey, made copious extracts from the report of Master Francis Winslow, as to the physical conditions and surroundings of the oyster-beds in Pokomoke and Tangier Sounds.

The researches and discoveries of Dr. Brooks indicated the possibility of resuscitating this important though waning industry of the State: but, unfortunately, Dr. Brooks was prevented from carrying his experiments to such a length as to determine the best methods of taking advantage of the discovery of the possibilities of the artificial impregnation and production of the oyster.

The development of our oyster has been clearly marked and delineated in the report up to a state when it is a swimming animal and frequents the surface of the water. Unfortunately Dr. Brooks was not able to observe the continued development later than the sixth day, as the proper apparatus had not then been devised for the necessities of this service.

As this report contains some hints which may prove of much importance in the future, I take the liberty of again calling attention to them. Dr. Brooks says:

"All my attempts to get later stages than these failed, "through my inability to find any way to change the "water without losing the young oyster, and I am there-"fore unable to describe the manner in which the swim-"ming embryo becomes converted into the adult, but I "hope that this gap will be filled, either by future "observations of my own or by those of some other em-"bryologist.

"In my attempt to raise the oyster embryo from the

"egg, I found that continuous warm weather was essen-
"tial to success. As my observations upon the devel-
"oping eggs occupied all my time, I was not able to
"make any record of the temperature of the water of
"the ocean, but during June there were a number of
"cold, windy days and nights, and two hail-storms, and
"on each of the cold days all the embryo which I had
in the house died.

"At first sight it does not seem possible that an ani-
"mal which is encased in a hard, strong, protecting
"shell, and which is capable of giving rise to several
"million eggs every season, can be in any danger of
"extermination: and it seems as if the oyster ought to
"be able to hold its own in the struggle for existence,
"and to increase and multiply in the face of the most
"adverse circumstances.

"It appears wonderful that the waters of the Chesa-
"peake Bay are not paved with oysters, and persons
"who have not given much thought to the subject will
"ridicule the statement that there is any need for meas-
"ures to prevent their extermination or the destruction
"of the natural beds. While the consumption of oys-
"ters was restricted to regions in the immediate vicinity
"of the beds, the number of oysters which it would pay
"to gather and put into the market each season from
"each bed was limited; but with the present facilities
"for packing and transporting oysters, there is no limit
"to the number which can be utilized, and the danger
"of destroying the best beds grows greater every day,
"and keeps pace with the increasing population and
"improvements in transportation."

After giving some statistics of the catch of oysters in the Bay of Cancale, Dr. Brooks further remarks:

"The table also shows that it will not answer to rely
"upon the very great number of eggs, and therefore
"trust to a few oysters the work of replenishing the
"bed.

"In view of such facts, no one who appreciates the "magnitude of the oyster industry of the Chesapeake "can doubt that the protection of the natural oyster "beds is a matter which is worthy of the most careful "attention. While the manner in which this is to be "accomplished is outside the scope of the present paper, "a statement of those favorable and unfavorable influ- "ences which have suggested themselves to me during "my work, may fairly find a place here.

"It is well known to naturalists that the number of "individuals which reach maturity in any species of "animals or plants does not depend upon the number "which are born. The common tape-worm lays hun- "dreds of millions of eggs in a very short time, yet it is "comparatively rare. The number of children born to "each pair of human beings during their lifetime of from "fifty to eighty years, can be counted on the fingers, yet "man is the most abundant of the larger mammals, and "human population increases quite rapidly under favor- "able circumstances. This comparison shows plainly "that the abundance of a species is determined, mainly, "by the external conditions to which it is exposed, and "that the number of individuals which are born has "very little to do with it. In the case of the oyster, the "adult is well protected against enemies by the shell, "and as its food is abundant, and is brought to it by "the water, it is tolerably sure of a long life after it has "reached its adult form, but the life of the young is "very precarious; that of the young American oyster "peculiarly so, since it is exposed to all kinds of ene- "mies and accidents, at a time when it is most helpless. "The protection of the young European oyster by the "parent shell at this time would seem to more than bal- "ance the greater number of eggs laid by the American.

"The most critical time in the life of the American "oyster is undoubtedly the time when the egg is dis- "charged into the water to be fertilized, for the chance

"that each egg which floats out into the ocean to shift "for itself will immediately meet with a male cell is very "slight, and it is essestial that the egg should be fertil- "ized very quickly, for the unfertilized egg is destroyed "by the sea water in a very short time. The next period "of great danger is the short time during which the "embryos swarm to the surface of the water. They are "so perfectly defenceless, and so crowded together close "to the surface, that a small fish, swimming along with "open mouth, might easily swallow in a few mouthfulls "a number equal to the human population of Baltimore. "They are also exposed to sudden changes of tempera- "ture, and as my experiments have shown that a sudden "fall in temperature is fatal to them at this time, the "number which are destroyed by cold rains and winds "must be very great indeed.

"As soon as they are safely past this stage, and scatter "and swim at various depths, their danger from accidents "and enemies is greatly diminished, and their chance of "reaching maturity increases hundreds, and probably "thousands of times.

"My experiments show that there is no difficulty in "developing them up to this point in the house in small "aquaria, and in carrying them safely past the most "precarious part of their lives, and freeing them from "all their greatest dangers."

The importance of carrying the investigations beyond the point reached by Dr. Brooks, induced me to secure the services of Professor John A. Ryder, of the Philadelphia Academy of Sciences, and having provided quite an assortment of collectors, I stationed him in the month of July at the mouth of the south fork of St. Jerome's Creek, in St. Mary's County. This creek flows into the Chesapeake a few miles north of Point Lookout.

Having secured the use of ponds, formed by a prong of this creek, it was my intention to arrange them so as thoroughly to control the ebb and flow of the tide

and the inflow of fresh water from the drainage of the land adjacent, by providing embankments, flood-gates, and waste-ways; but the unexpected diversion of a large portion of the appropriation prevented my carrying into effect these plans, so important for an exhaustive study of the subject.

In order to enable Prof. Ryder to carry on his experiments in a thorough and systematic manner, it was essential that a limited body of water should be isolated from the creek and the water be under complete control. It was important, also, that means should be provided that the enemies of the young oyster, as far as practicable, should be excluded.

Crude and imperfect as were the means available, Prof. Ryder pursued the line of investigations with important results, although he experienced the same difficulty in keeping the young oyster as did Dr. Brooks.

He was enabled during his stay at St. Jerome's to determine with some accuracy the rate of growth of the "spat" and to make very important researches as to the food and manner of fattening the oyster.

Prof. Ryder's report, which is full of interest, will be found in the appendix, and its careful perusal is earnestly recommended, as his cautious utterances should guide us to the future solution of this important question.

As soon as it can be done without detriment to the other important branches of fish culture, I trust that, with the additional light which has been shed upon this subject, I shall be able to provide Prof. Ryder with proper apparatus for the prosecution of these important investigations, for I am quite satisfied that as soon as we are able to artificially produce the oyster and protect the young until it finally attaches itself to some stationary object, we will have certain means of multiplying this bivalve to an unlimited extent and of furnishing it for planting purposes at less cost than can now be done by the dredging process. We will also be able with cer-

tainty to replenish beds which have been so far exhausted as to have lost, to a great extent, the power of reproduction in themselves, and to establish new beds in localities where the oyster does not now exist.

I trust that the experiments made and to be hereafter conducted, will enable us to determine the best form of collector to be used in our waters and the best manner in which it should be treated and the attached young oyster cared for.

The importance of the discoveries as to the means of artificial propagation of the oyster can be appreciated when we take into consideration the fact, that the soils and localities which are favorable for the reproduction of oysters are not always favorable for their subsequent development, as there are many places where oysters thrive but where they will not breed, it being generally accepted that the best conditions for propagation are sandy and gravelly bottoms and quite salt water, whereas muddy bottoms and a mixture of fresh water are most favorable for fattening.

The many conditions which influence the breeding, growth and development of the oyster—that is the soil, temperature, sudden alternation of heat and cold, direction of current, the occurrence of very low water at periods of extreme heat or extreme cold, and many other natural conditions, all indicate the importance of establishing now the artificial propagation of the oyster, notwithstanding its wonderful reproductive capabilities.

The importance of the oyster of the Chesapeake Bay can be appreciated by a perusal of the following figures, which I have obtained through the courtesy of Professor G. Brown Goode, Superintendent in charge of the fishery statistics of the census of 1880:

OYSTER WORK IN MARYLAND 1879—80.

Kind of Boat Employed.	Number.	Value of Boat and Equipment.	No. Men Employed.	Wages of Same.	No. People Supported by Oyster Catch'g.
Dredgers	700	$1,050,000	5,600	$ 916,300	
outfit of same		70,000			
Scrapers	550	440,000	2,200	297,000	
Canoes	1,825	182,500	5,148	1,158,300	
Runners	200	300,000	800	166,400	
	3,275	$2,042,500	13,748	$2,538,000	54,992

Number of Oysters Taken 1879—80.	Bushels.
No. packed in State—of Md. oysters	6,653,492
" shipped out of State	2,021,840
Local consumption in Baltimore	818,680
" " other cities of the State	200,000
" " counties	875,000
	10,569,012

It will be seen that in the year 1879 to 1880, there were 13,748 of our citizens employed in catching and bringing to market the ten and a half million of bushels produced; and when we take this into consideration and the amount of capital consumed in preserving and exporting the oyster, the importance of providing for a continued supply is most evident.

The Chesapeake Bay, situated, as it is, between the colder waters of the north and the warmer southern zone, is unexceptionally suited for the cultivation of the oyster, its reproduction, growth and fattening, as it is not exposed to those vicissitudes of temperature which so frequently prove fatal; and the limited average in the rise and fall of the tide renders the existence of the oyster in shoal waters less precarious and their protection far less expensive than it has proved on the coast of France, where the oyster-growing industry has added new life

and prosperity to portions of the coast which were fast becoming impoverished.

The facility for working the oyster parks at low tide in localities where there is a very great rise and fall of tide, is more than neutralized by the costly arrangements which must be devised for keeping them sufficiently covered to prevent their exposure to destruction, which would be the result were they laid bare at critical periods; yet, although oyster culture has hardly existed a decade, the promises of success have been more than realized, and results have been obtained by the employment of methods so simple, that the proprietor of any oyster establishment will readily undertake to supply millions of oysters to any one wishing to enter upon their cultivation.

When we have ascertained with precision the period of attachment, when the spat forsakes its roving existence for a settled life, and have demonstrated that the oyster can be produced in unlimited numbers and successfully protected until this attachment is made, we will have gone far beyond those methods which have produced such good results in European countries, and it will be then necessary to take advantage of their experiences for the determination of the best form of collectors and the subsequent treatment of the oyster until it is sent in a perfect state to market.

It may, therefore, be more appropriate to reserve for a future report the details as to the form of collectors, information which I obtained during a recent examination of the typical oyster cultural farms of France. The determination of the form of collector best suited for the several localities of the Chesapeake Bay must be determined by actual experiment with the *chaplet*, (collector formed of shells strung on galvanized wire,) the favorite in the Bay of Arcachon; the *bouquet*, (collector formed of twelve tiles secured around a stake which hold them in position,) a form much used in the neighborhood

of Vanne and Auray: the *shingle*, *slate*, *brush*, *pottery* and other forms of collectors, severally the favorites in various localities.

Having advanced thus far in our experiments, it would be well for us to follow the methods of treatment and preparation of the oyster in practice at Courseulles, Les Sables D'Oleron and Marennes, where the energy of the culturalist is devoted to the fattening of the oyster for market.

The oyster industry forms too considerable a portion of the wealth of the Chesapeake Bay and is of too much commercial value to be allowed to suffer decline.

I trust that we may be enabled to prosecute our inquiries so as to present to the consideration of the Legislature the unanswerable logic of facts and suggest the methods of protection and devise means for continuing an ample supply of a great blessing which, although lavishly enjoyed, has scarcely been fully appreciated.

It is to be feared that much of the previous legislation has been ineffective, as based on evidence defective and misleading in its character, the result of misstatements and convictions formed by conflicting advice given by interested persons or by those misguided by too imperfect observation.

Respectfully submitted,

T. B. FERGUSON,

Commissioner.

APPENDIX A.

AN ACCOUNT

OF

Experiments in Oyster Culture

AND

OBSERVATIONS RELATING THERETO,

Made at St. Jerome's Creek, Md., during the Summer of 1880,

BY

JOHN A. RYDER.

INTRODUCTORY.

On the 18th of July last, Maj. T. B. Ferguson, Commissioner, having completed the preliminary arrangements looking forward to the establishment of an experimental station where every opportunity should be offered for the cultivation of the oyster by artificial means, employed the writer to carry on the necessary work of experiment and observation. The locality chosen for our operations by the Commissioner, was about seven miles north of the mouth of the Potomac River, on the western shore of the Chesapeake Bay, in St. Mary's Co., Md., and forms part of an inlet extending several miles inland, known as St. Jerome's Creek. Here, a pond, covering an area of perhaps two or three acres, which is joined to the main body of the creek by a narrow run or canal, through which the tide ebbs and flows, was chosen with the design of converting it into a *claire* or oyster park, somewhat similar to those in successful operation on the coast of France. The pond having been leased from the owner, Mr. J. W. Wrightson, for a term of years, with the privilege of making such improvements as might be necessary in carrying on the work of oyster culture, presents, in all respects, as favorable a situation in the opinion of the writer, for the purpose intended, as could be desired.

After some delay in getting our work agoing, we succeeded however, in obtaining some results and many experiences, which will be of great use in guiding us to the attainment of better results in the future. My object, in the main, was to learn what were the difficulties which would beset us in our future work and to find out what methods might suggest themselves as better calculated to further our efforts next season. The time of breeding

was already nearly half over when our work began, and to this, as much as to anything, the comparative unsatisfactoriness of our results must be attributed. While we are forced to admit so much, a large amount of valuable information has been gathered, a good deal of which is entirely new to science and very suggestive as to what will be the proper paths to follow hereafter in the conduct of the work.

We have devoted a considerable amount of space to an account of the structure of the oyster, with illustrations, so as to make it easier for the anatomy and physiology of the animal to be understood by persons not familiar or within reach of the treatises on the subject. The idea has not been, to tacitly imply that the account given by Prof. Brooks in last year's report was not a good one, but simply to illustrate pictorially, as far as lay in my power, the grosser anatomy of the creature, so as to enable a novice to find the ovaries and spermaries of the animals more readily if it should be desired to impregnate the eggs artificially, either for the sake of experiment or artificial culture.

The numerous suggestions which have been made throughout the body of the text as to the extension of the banks and the possible practicability of entirely new plans of culture will, I hope, be found of value. The matters of mere scientific record and observation are such as would have been noted by any observer, endowed with a fair share of common sense and having a naturalist's training.

The appended observations on the artificial impregnation of the European oyster made by Francis Winslow, U. S. N., are important, as showing how closely parallel the phenomena of development in this species are to those of our own. I place entire confidence in these observations, as they are fully supported by what was previously known of their development through the research-

es of Davaine, Salensky and others, who, however, have failed to see the earliest stages.

The note on the development of *Mya arenaria* is added merely to establish the time of the spawning season; to show that it is possible to impregnate the eggs artificially, and to indicate to some extent the nature of the process of development, the study of which I could not complete owing to illness.

The histology of the ovaries of both the oyster and clam remains to be studied, since it is possible only by that means to ascertain whether the whole of the eggs are mature at one time. The researches of Flemming and Von Jhering show that such is not the case in *Unio* and *Scrobicularia*. Much of the success of future attempts at artificial incubation depends upon a decisive answer to this question. My own experience in investigating the ovaries of *Ostrea* and *Mya*, countenances the belief in my mind, that the time of maturity for nearly all the ovarian eggs is about the same.

The question as to the exact age of the fry of the oyster at the time of fixation, as well as the age of the fry of *Mya* at the time it buries itself in the sand, also awaits an answer; but it is the hope of the writer that, with an incubating apparatus which he has lately devised as an adjunct to his microscope, he may in the course of another season's work, reach a satisfactory conclusion in regard to this, as well as many other important matters.

ANATOMY OF THE OYSTER.

THE SHELL.

In view of the fact that the structure of the American oyster has hitherto excited comparatively little attention, we offer here the results of investigations made upon thirty-seven specimens. The best account which is known to me, and one accompanied with a good figure, is that given by H. James Clark*, and which anticipates in many respects, a note contributed by the writer to the *American Naturalist* for September, 1880. Another admirable account of the structure of this mollusc has been given by Prof. W. K. Brooks†, but after comparison, I find that my observations are not wholly in accord with the accounts of either of these careful observers.

In Fig. I, I have attempted to represent in a somewhat diagrammatic manner the structure of the animal under consideration, with indications of some of its physiological or animal processes, such as the inhalation and exhalation of water for breathing purposes, and the manner in which the food is carried to the mouth to be swallowed.

The oyster always presents a definite right and left side, and the two shells or valves which enclose the animal, always differ in that the left one is more deeply concave or hollowed out than the right, which is nearly flat. In the natural beds the left valve is usually, if not always undermost, but in the crowded banks the animal usually assumes a vertical position, a condition which does not, however, affect this unlikeness of the valves. In the figure, the left valve has been removed, the animal of the oyster is shown lying in the more shallow right. The head end of the animal lies close against the

*Mind in Nature. New York, 1865. pp. 199—203.
†Report of the Maryland Commissioners of Fisheries, 1880. pp. 5—10.

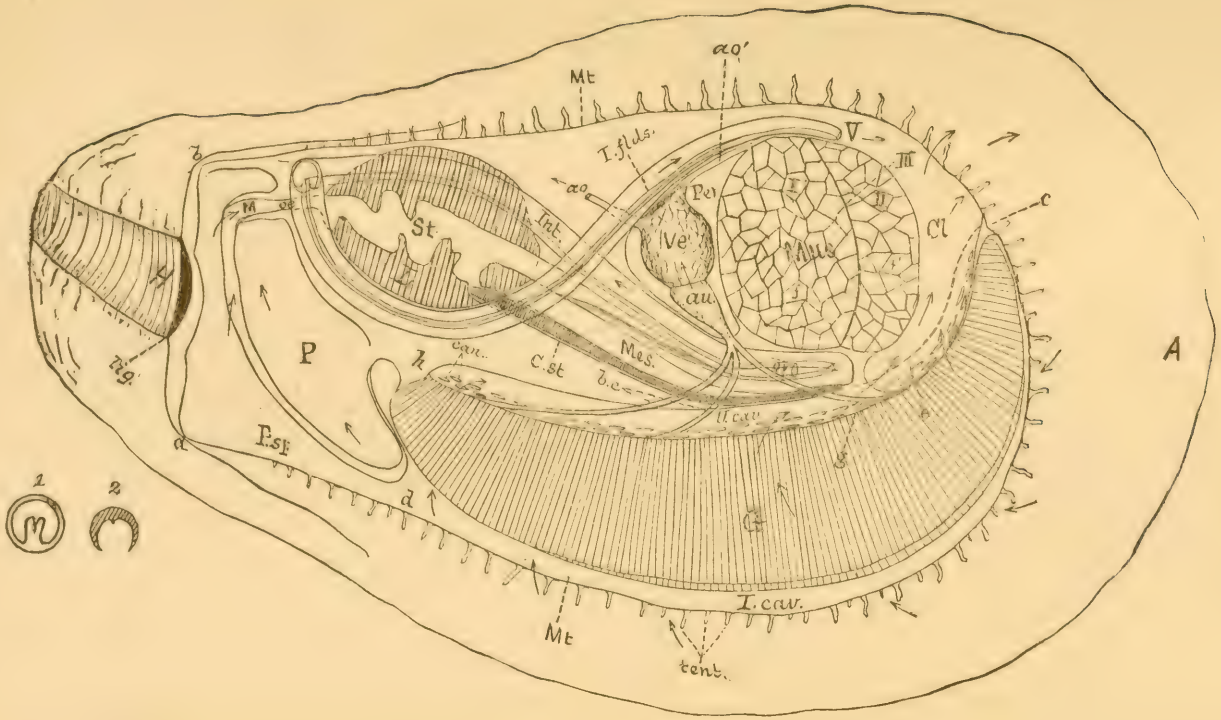

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Figure I.

hinge *H*, or the point where the two valves are firmly fixed to each other by a dark brown crescent-shaped body, the ligament *lig.*, which, while it serves to attach, also tends by reason of its elastic properties to cause the valves to separate at their free borders at *A*, in order to allow the passage of water inwards to the gills *G*, and of food to the mouth *M*, while it also allows the water which has passed through the gills to escape by way of the cloaca *Cl*, carrying with it in its passage the faeces from the vent *V*. The tendency to separate the valves, inherent in the ligament, is balanced by the adductor muscle *Mus*, which, upon the slightest intimation of danger, forcibly contracts, closing the free edges of the valves tightly. The dark purple scars near the centres of both valves, and vulgarly known as indicating the position of the "heart," are simply the areas covered by the attachment of this adductor muscle, which is composed of a vast number of extremely fine muscular fibers, which collectively pass straight across the space between the inside of the valves, being firmly fixed at either end to the latter. The muscle, when closely examined, is seen to be composed of bundles of fibers or fibrillæ, which may be called fibrils, each with its proper sheath, and polygonal in cross-section. The muscle is also made up of two kinds of fibers, the larger portion, embraced in the area I, are brownish gray, while those in the smaller area II are whitish; the line of contact between the two is sharply defined by the curved line III, where they are also easily separated as portions of a compound muscle. The foregoing fairly describes the mechanism of the shell, and in part the physiological significance of the same.

The structure of the shell is laminar, or in other words, it is composed of numerous layers of carbonate of lime deposited one on the other by the mantle (the latter to be described farther on,) probably from the blood or possibly in some other way. These layers de-

posited as they are internally, as growth proceeds project in succession past each other at the free edges of the valves and external surface of the shell, so that the successive deposits may frequently be distinguished, espepecially, as these deposits seem to be laid down periodically, giving rise to a very rough imbricated appearance of the edges of the layers on the outside of the shell. The inner pearly or nacreous layers of the shell are different in structure from the outer ones. These are made up of microscopic prisms of carbonate of lime embedded in a matrix of horny substance, analogous, if not identical with the substance which forms the external hard parts of insects. The outer portion of the shell, forming much the largest proportion of the whole, is differently constituted according to Nathusius-Königsborn*, who finds that in the shells of the oyster of Europe there are superimposed cavities, filled in life with water, which lie just beneath the inner pearly layers and between the attachment of the muscle and the hinge corresponding to the thickened nacreous portion. In the thick marginal portion of the shell, extending from a point half way between the insertion of the muscle and hinge, to near the edge of the valves, he finds still another series of closed cavities which are separated by oblique divisions of a laminar character, and which are filled with a singular structure of minute cavities which contain air. The first kind or the water bearing cavities are, it may be well to remark, greatly developed in *Spondylus*, an ally of the oyster. The laminar character of the shell is apparent from the presence of very fine lines of growth even on the valves of the free-swimming embryos, and in the embryonic shell which covers like a little raised cap the extreme tips of the umbos or hinge ends of the valves of attached spat ¼ to 1 inch in diameter.

During the past season I endeavored to ascertain if it

*Untersuchungen ueber nicht cellul're Organismen, namentlich; Crustaceen-panzer, Mollusken—Schalen und Eihüllen. Von W. Von Nathusius-Königsborn. 4 to., pp. 144, pls. 16. Berlin, 1877.

was not possible to determine the age of marketable oysters from what appeared to be annual arrests of growth, indicated on the outside of the shell by deeply impressed lines or projecting laminae placed at nearly equal distances apart, but I failed, after examining a great number of living and dead shells, to arrive at any satisfactory conclusion.

THE ANIMAL.

In Fig. I the head of the animal lies directed towards *H;* the tail end, on the other hand, lies towards *A;* the back or upper side of the animal extends from *b* to *c;* the ventral or lower side reaches from *c* to *a* up to the mouth *M*. The right and left sides of the animal are covered by an organ called the mantle *Mt. Mt.;* it is not attached to the shell anywhere except around the points where the ends of the adductor muscle, *Mus*, are fixed to the valves of either side. This organ encloses, like a curtain, the internal organs of the creature on either side, and lies next to the shell, and secretes and deposits the layers of carbonate of lime composing the latter. The free edges of the mantle, which are purplish, are garnished with small, highly sensitive tentacles *tent.* of the same color, and which serve the purpose of organs of touch and are perhaps also to some extent sensitive to light. The borders of the right and left folds of the mantle are free from *b* to *c*, where they unite, and from *c* to *a*, but from *a* to *b* they are joined together. In the space between the right and left folds of the mantle from *b*, *a* to *d*, the palps *P*, or lips of the oyster, are included; this cavity may be called the palpal space *P. sp.* The palpal space is continuous with the inferior gill cavity *I. cav.*, from *d* to *e;* in this space, bounded like the latter on each side by the mantle, the four leaf-like branchiae or gills *G* hang suspended by a membrane, which unites with the mantle on either side along the line *e;* this membrane, together with the bases of the gills, forms a cavity limited below by the upper edges of the gills at *g*

and above by the viscera along the line below *C. st.*, the mesosoma *mes.* or lower middle portion of the body and the adductor muscle; this upper gill cavity *U. cav.*, extends from *b* to *c* and is continuous with the cloaca *Cl*, which is the space between the upper free folds of the mantle from *b* to *c*.

The physiological significance of this arrangement of parts will be understood by noting the directions in which the arrows are supposed to be moving. As the living oyster lies fixed at the bottom of the water with the free edges *A* of the valves slightly separated, the minute cilia or hair-like processes with which the gills and palps are covered, are constantly in rapid vibratory motion; this peculiar movement over the gills and palps causes a current of water to travel from without into the inferior gill cavity *L. cav.*, a part of which passes on to be carried by the cilia of the palps towards the mouth for the sake of the microscopic food it may contain in suspension; after this has been gleaned out, the water probably passes back to the inferior gill-cavity between the pendulous lobes of the outer and inner pairs of palps. The fate of the water which passes through the gills is entirely different, though the gills seem to take part in carrying food towards the palps and mouth, a phenomenon which may be readily rendered apparent to the eye by scattering powdered cochineal or fine meal on the gills or palps, when it will be seen that the motion of the cilia on both organs causes the particles to move with considerable rapidity towards the mouth. The water passes up between the leaves of the gills, actuated by ciliary motion, and enters the upper gill cavity through a large number of openings or canals between the gills *can.* and passes out towards the cloaca *Cl*, into which the vent *V* also discharges its excreta, and is so carried out of the animal back into the surrounding water. The whole of the process of respiration or aeration of the blood appears to be effected in the gills proper.

The transversely elongated mouth *M.* of the oyster lies between the upper bends of the palps, it is followed by a very short gullet or oesophagus *oe*, which opens into the stomach *St*, the walls of which are very much folded and wrinkled, the folds often dip into the substance of the massive brownish green liver *L.* and give entrance to the numerous and spacious bile ducts of the latter. At the hinder end of the stomach one of the deep folds appears to be continued backwards in the form of a blind, cylindrical pouch to or beyond and between the openings of the oviducts of either side; this pouch contains a transparent, but at the same time opalescent rod, the so-called crystalline style *Cr st*, the function of which is not known. The intestine as it first leaves the stomach proper is somewhat wider than at other points, but I do not know why Prof. H. J. Clark considered this portion, as far back as the first bend, part of the stomach. It seems to me that the irregular digestive cavity enclosed in the liver-mass should be regarded as the stomach, because the first portion of the intestine already contains the commencement of a peculiar pair of folds running lengthwise, which will be spoken of later. Returning to the course of the intestine *Int*, after passing backwards beneath the adductor muscle, into the mesosomal or middle part of the body, when it suddenly bends and is prolonged toward the head, passing a little to the right of the stomach and along the back of the animal, when it again suddenly turns to the left and crossing the gullet *oe*, descends in a gentle curve along the left, lower side of the body, passing obliquely upwards over the pericardial space *Per*, which contains the heart, to end in the anal opening at *V*. A peculiar double fold, *I. flds*, which projects into the intestinal cavity, extends from the pyloric end of the intestine to the vent; its function is probably to afford a greater amount of surface for the absorption of nutriment, or it may be valvular in character. The greater portion of the inner intestinal surfaces

are probably covered with cilia in more or less active motion, for all the portions of the lining of the stomach and intestine examined by me appeared to be provided with a ciliary covering. The faeces of the oyster are not extruded in the form of a cylinder as in many other mollusks, but have the form of a demicylinder with one side excavated in a groove-like manner, as shown in section in Fig. I, 2, the peculiar form being due to the presence of the longitudinal folds in the intestine, as shown in a cross-section of the latter in Fig. I, 1. In *Unio*, the fresh-water mussel, a similar arrangement is said to exist, according to Bronn; (Klass. u. Ord. des Thierreichs, III, p. 364.)

The course of the intestine as sketched above is most nearly in accord with Clark's account; the figures given by Sir Everard Home* of the intestine of *Ostrea edulis* are also in close agreement, but the proper relation of the mouth and palps was evidently not understood. Home's figure, however, fully justifies, with other evidence, the criticism made in Woodward's Manual of the Mollusca, regarding the inaccuracy of Poli's† figures of the same parts.

The systemic heart is that organ which serves to propel and continually redistribute the colorless blood of the oyster through the body for its nourishment, and through the gills that the blood itself may discharge into the water the poisonous gases with which it is loaded in passing through the body, and receive a fresh supply of oxygen as fresh supplies of water pass through the gills. The heart consists of three chambers; the upper and largest is the ventricle *ve*, and the two smaller, lowermost, brownish, paired chambers are called auricles *au*; the three chambers lie in a crescent-shaped space, the pericardial space *Per*, just forward of the adductor muscle. The ventricle *ve*, is almost globular;

*Philos. Trans. 1827, pl. IV.

†Testacea Utriusque Siciliae eorumque Historia et Anatome, II. Tab. XXIX, fig. 3. Parma, 1795, Fol.

its walls are made up of a delicate meshwork of muscular fibers so interlaced as to be altogether untraceable; by its contractions it forces the oxygenated blood fresh from the gills to all parts of the body through two large vessels, or properly, aortae, the first, *ao*, supplying the forepart of the body, and *ao'* the hinder portion. These larger vessels divide into smaller ones which effect the distribution of the blood towards the head, and through the viscera, where, as in other parts of the body, a network of fine capillary vessels exists. The blood accumulates perhaps in sinuses, one of which is the pericardial space, and there are besides probably a pair of rudimentary ones in the oyster, the vestibule of a rudimentary organ of Bojanus, from these, through the venous system of vessels, the blood is carried back to the gills to be aerated, and returned through the vessels which carry the blood from the gills to the auricles, the branchiocardiac vessels *bc*. Of the last, there are three on each side of the oyster, two pairs of which collect the blood from the forepart of the gills, and one pair of which gather the blood from the posteriar portion of the gills to be carried to the auricles, from whence it enters the ventricle, having completed its circulation through the whole vascular system.

It is frequently noticed that the edges or a considerable part of the mantle of the oyster is very much swollen and nearly transparent, as though greatly distended with water; this is due to a peculiar arrangement of capillary vessels connected with the blood-system which causes the blood to be held in these places until turgescence is produced as in erectile tissues. The presence of an unusual amount of water in the blood no doubt sometimes helps to produce this last effect, since the blood-system is probably in communication with the water outside, through the openings from without into the organ of Bojanus, a part which answers to the kidney in other bivalve mollusks, but which seems to be

very rudimentary in the oyster. When oysters are removed from salt water to that which is less salt, a similar enlargement of the animal takes place, which may be entirely attributed to the effect of the action of the well-known laws of osmosis, and should not be regarded as a fattening process at all, since the real "fat" of the oyster is something vastly more substantial than water, as will be learned in the sequel. Prof. P. Frazer, Jr.,* has discussed the subject of fattening oysters by means of osmosis.

For my own part I believe that the turgid, translucent appearance of the edges of the mantle in the oyster is due to the passage inwards of water through the mouths of numerous vessels which open freely on its surface; these from my microscopic examinations seemed to be the extremities of the capillaries of the mantle, and I find that for this belief I have the concurrent testimony of other writers, (Bronn; Klass. u. Ord. III, 384.)

The nervous system of the oyster is very simple, being composed of a pair of ganglia or masses of nervous matter, which lie just over the gullet, and from which a pair of nerve cords pass backwards, one on each side, to join the hinder pair which lie just beneath the adductor muscle. The mantle receives nerve branches from the hindmost ganglia, and these control the contraction and elongation of the radiating bundles of muscular fibers as well as those which lie lengthwise along the margin: the former contract and withdraw the edges of the mantle from the margin of the shell, while the latter in contracting tend to crimp or fold its edges. The tentacles, or organs of touch, are also mainly supplied from the hindmost ganglia, while the internal organs are innervated from the head ganglia.

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*On Dialysis in Oyster Culture. Proc. Acad. Nat. Sciences, 27. 1875, pp. 442—43.

The generative organs of the oyster, *Gen.* Fig. 2, are massive in proportion to the size of the animal; they invest the whole of the visceral mass from a little behind the palps to the pericardial space, extending beyond it posteriorly above and below. They invest the rectum to within a short distance of the vent and the first bend of the intestine below the adductor muscle; their substance also dips down deep amongst the viscera so as to appear to cover the intestines, the pouch of the crystalline style and the liver. The sexes of the oyster are distinct, but

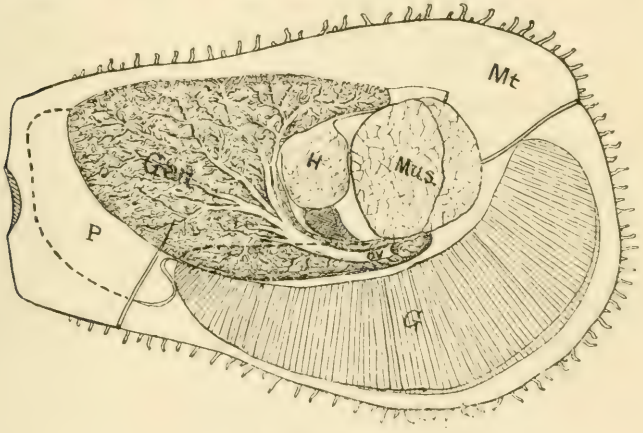


Figure 2.

there is no apparent possibility of determining the sexes from the external appearance of the generative tissues, since there seem to be no differences between what in one case are ovaries containing eggs, and in another spermaries or testes, containing the male cells or spermatozoa. Both kinds of glands are composed of a great number of tubular branches which unite into two large canals, one on each side of the body, which open into thr upper gill cavity at *or*; the oviducts if the specimen be female, and *vasa deferentia* if the specimen be a male. The smaller branches divide and subdivide, as may be noted in Fig. 2, giving off ultimately short blind, pouch-like branches, which are the follicles of the glands or

acini, on the inner walls of which the ova or eggs and spermatozoa are developed. The eggs in the female grow from ovicells, and in the male the spermatozoa originate from cells which are known as spermogens.

In having a pair of openings, one on either side for the escape of the generative products, our oyster agrees perfectly with that of Europe, according to H. Lacaze-Duthiers.* Davaine,† in his memoir, asserts both in his text and in his figures that the generative glands of the European oyster have three openings on either side, statements which are not in accord either with facts or analogy. In a paper by Sir Everard Home, which we have noticed before, he erroneously regards the suprabranchial or upper gill cavity as an oviduct.

No evidence to show that our oyster is hermaphrodite was found during the entire season, nor were my searches for embryos or eggs on the mantle and in the gills any more successful than those carried on two years before by Prof. Brooks. There is no doubt whatever that the oyster of Europe nurses its young on its mantle and gills for some time, nor can we very well question the very high authority of Möbius for saying that in most cases the sexes are separate, and that but one kind of products, viz. ; either eggs or spermatozoa are at any one time found in the generative organs; Lacaze-Duthiers' observations seem to confirm the conclusions of Möbius.

As the eggs and spermatozoa ripen and are set set free in the little terminal sacs or acini of the generative organs, they are probably pushed or driven out of the larger canals which connect with the terminal sacs, and which join the main oviduct *ov*, by means of cilia which line these canals, as suggested by Lacaze-Duthiers, just as the food is carried to the mouth and the water continually forced through the gills by the waving of the innu-

*Recherches sur les Organes genitaux des Acephales Lamellibranches. Ann des Sci. Natu relles. 4 ser , zool., t. 2, pl. 8, pp. 214—228. Paris, 1855.

†Mem. de la Soc. de Biol. IV, 1852, pp. 297—339, pls. I—II.

merable cilia which cover the latter and the palps. The oviducts open directly into the upper gill cavity, from whence the eggs or sperm which have been discharged thereinto are at once carried out into the water immediately surrounding the animal in the open sea. From the fact that the eggs are heavier than water, although each female oyster matures many millions, it is easy to understand why it is that but comparatively few, probably only a fraction of one per centum of all that are laid, ever develope or fix themselves even under favorable circumstances, since much the largest portion of them are never impregnated, while of those which are, but few ever find positions favorable to their growth under natural conditions.

HOW AN OYSTER TAKES ON FLESH.

Amongst oystermen the business of "fattening" or feeding the oyster is one of the most important from the fact that upon the condition of the marketable product largely depends its value. Fatness in the oyster is a condition wholly different in nature from the state known under that name in stall-fed domestic animals; nor has it anything to do with the condition of the reproductive organ, as Prof. Brooks* seems to suppose, for oysters are mainly taken from their beds at a season when that organ is in an inactive condition and appears shrunken and wasted away, as it truly is. The word "fat" as applied to indicate the condition of the oyster when in flesh, is a misnomer, since it is not fat at all which is the immediate cause of the condition of plumpness, which betokens a fitness for market, but a very extensive deposit of protoplasmic material which has been mainly laid down in the substance of the mantle. It is not denied that there are oil globules to be found in this deposit, but it *is* denied that the term "fat" applies as

*Development of the American Oyster, p. 10.

N. B. Möbius seems to have clearly apprehended the true nature of the so-called fattening process.

descriptive of it. It is this relatively large amount of delicate, easily digested protoplasm of the mantle which renders the oyster so wholesome and nutritious.

The deposit of this protoplasmic material in the mantle, palps and body, stands in intimate relation to the activity of the reproductive organs. During the spawning season oysters are said to be "poor," that is, poor in condition, for at this time the mantle, especially where it lies next the body on each side, is very thin and quite transparent; the radiating muscles at the edges as well as its vessels and nerves may now be readily studied under the microscope, owing to the transparency and absence of soft granular protoplasm. If we examine at this time the reproductive organs, as a rule, we will find them greatly developed and pouring out their products through two large ducts, the combined caliber of which is not far short of that of the intestine. It will be evident to any thinking mind that if the major part of the food material elaborated by the stomach and intestine goes to the ovary or testes to be transformed into sex products, which are continually thrown off, little of such material can be stored up in the tissues of the body.—This is exactly what happens. In the month of September when the oysters for the most part stop spawning, the drain of elaborated material having ceased to flow from the openings of the reproductive organs, it is diverted in another direction, but is retained in the system, and has to be deposited somewhere in the body. The most extensive deposits of this elaborated living matter occur in the mantle, body and palps, the color of which rapidly changes from the watery transparent condition prevalent during the spawning season to a creamy white. The mantle and palps now become very much thicker than before, and their substance appears to be softer, more easily lacerated, and is made up largely of a delicate granular protoplasm, which when broken up has the milky appearance of the reproductive organ

when it is mutilated. I have known this milky appearance of the mutilated mantle of the oyster to lead persons to mistake it for the reproductive organ; a mistake easily made by the inexperienced.

The preceding account of the physiology of the so-called fattening process will serve to prove how little philosophy there is in the doctrine that oysters may be fattened by putting them for a day or two in water less salt than that from which they were first taken, in order that they may be water-swollen by the action of osmose so as to give them a plump appearance.

Upon making an examination of some oysters to-day (Dec. 6th,) to learn something in regard to the nature of the so-called fatty material contained in the thickened mantle, I find that it is made up of nucleated cells composed of a fine corpuscular material. The protoplasmic granules are so fine that they remind one, when examined under a power of 250 diameters, of the corpuscles found in milk, though they are probably quite different in nature. They manifest the dancing motion when highly magnified, which is known as pedesis or the Brownian movement, and appear to be perfectly spherical with considerable variation in size. Upon examining another specimen I found the principal ducts of the testes already defined, and upon microscopic examination an abundance of active, though not perfectly mature, spermatozoa were noticed. The spermaries in this case may no doubt be considered as a part of the fat, but the case is most interesting as showing how very early in the season the generative products commence to develop.

FOOD OF THE OYSTER.

The food of this mollusk, as is well known, consists entirely of microscopic beings and fragments of organic matter, which are carried by currents from the palps and gills, which have been already described, to the large mouth of the animal at the hinge end of the shell. The inside of the gullet and stomach, like some other parts of

the body, are covered with cilia, so that food once fairly in the mouth will be carried by their action down to the cavity of the stomach, where it is carried into the folds and deep pouches in its walls and even into the openings of the bile ducts, to undergo digestion or solution, so as to be fitted in its passage through the intestine, to be taken into the circulation, and finally disposed of in building up the structures of the body.

Along with the food which is taken, a very large amount of undigestible dirt or inorganic matter is carried in, which in a great measure fills up the intestine together with the refuse or waste from the body. This material, when examined, reveals the fact that the oyster subsists largely on diatoms, a low type of moving plants which swim about in the water encased in minute sandstone cases or boxes of the most delicate beauty of workmanship. These, when found in the intestine, have usually had their living contents dissolved out by the action of the digestive juices of the stomach. I have found in our own species of oyster the shells of three different genera of diatoms, viz.: *Campylodiscus*, *Coscinodiscus* and *Navicula*. The first is a singularly bent form; the second is discoidal, and the last boat-shaped, and all are beautifully marked. Of these three types, I saw a number of species, especially of the latter, but as I was not an authority upon the systematic history of any of them, I had to neglect the determination of the species. No doubt many more forms are taken as food by the oyster, since I saw other forms in which the living matter inside the silicious cases was brown, the same as in most of the preceding forms, which I have indicated. Some of these brown forms were so plentiful as to color a considerable surface whereon they grew, of the same tint as themselves. But in no instance have I found any indications of the animal of the oyster becoming colored by feeding on these diatoms, as it is said the European oyster does when feeding on *Navicula ostrearia*, which

is green, imparting its own green color to the fluids and thus to the tissues of such oysters as may be so situated as to readily feed upon it. A recent writer* gives an account of some experiments made by M. Puysegur of Sissable in artificially producing this green color, from which I quote: "In each plate, [filled with water charged "with green diatoms,] according to its size, we put three "to six perfectly white oysters which had never been in "the 'clears' and the shells of which had been previously "washed and brushed clean. In similar plates like num-"bers of the same oysters were laid in ordinary sea-"water. Twenty-six hours after the commencement of "the experiment the oysters in the water charged with "diatoms had all acquired a marked greenish hue; the "other oysters remained unaltered. * * * * "After the oyster had turned green, it was laid in ordi-"nary sea-water for a few days, when the greenness dis-"appeared altogether. It reappeared when the oyster "was replaced in fresh water containing *Naricula ostre-*"*aria*." M. Decaisne, of the *Jardin des Plantes*, Paris, repeated the experiments with the same results.

Besides the diatoms, the spores of algae, the larvae or young of many animals, such as Sponges, Bryozoa, Hydroids, Worms, Mollusks, many of which are small enough to be taken in by the oyster, though their bodies in most cases being soft and without a skeleton, it is impossible to find any traces, either in the stomach or intestine, of their remains, to indicate that they have formed a part of the bill of fare of the animal. What, however, demonstrates that such small larval organisms do help to feed the oyster, is the fact that, at the heads of the small inlets or creeks along the Chesapeake, where the water is but little affected by the tides and is somewhat brackish and inclined to be stagnant, there always appears to be a relatively greater development of a some-

*The green color of Oysters, H. M. C. In *Nature*, Vol XXII, 549—50, 1880. Trans. from the Revue Maritime et Coloniale, February, 1880.

what characteristic surface or shallow water fauna of minute forms.

In St. Jerome's Creek the microscopic fauna of its head waters is entirely different from that of the body of the creek; two minute forms inhabit in vast numbers the former, while I sought in vain for them in the more open and changeable waters of the main body of the inlet, which are brought into active movement twice a day by the action of the tides. One of these forms an Infusorian*, 1-25th of an inch in length, was found covering every available surface of attachment, so that countless multitudes of the naked young would be swimming about in the water previous to building the curious spiral tubes which they inhabit: admirably fitted in this state as food for the oyster. Beside the type referred to there were a number of other Infusorians which in their so-called swarming stages of development, the young would become available as oyster food. Of such types I noticed four different species, either belonging or very nearly related to the genus *Cothurnia*; all of the forms built tubes for themselves. I also noticed several forms of bell-animalcules, the swarmers of which would become available as food for the oysters lying in the vicinity.

The diatoms did not seem to me to be more abundant in the head waters than in the open creek. There was one moss animal, of remarkable character, which I found in the head waters only, this creature was very abundant, and no doubt its embryos like those of the infusoria referred to, were available as food.

Of free swimming Infusorians, I noticed a number of genera; one especially attracted my attention from its snake-like appearance and singularly rapid contortions; it had a tuft of vibrating hairs or cilia at the head end in close relation with the mouth. Another more abundant type was the curious genus *Euplotes*, with a thick shell enclosing the soft protoplasm of the body: the latter

*On the occurrence of *Freia producta*, Wright, in the Chesapeake Bay. *Am. Naturalist*, 1880, pp. 810—11.

was of an oval form, flat beneath and rounded on the back, so that the resemblance when the large foot like cilia were in motion, carrying the animal about, was strikingly like a very minute tortoise, the resemblance being heightened when the animal was viewed from the side.

Rod-like algae, of minute size, the larvae of crustacea, especially the vast numbers of extremely small larval *Copepoda* must enter as a perceptible factor into the food supply of the oyster.

There is no doubt but that the comparatively quiescent condition of the head waters of these inlets and creeks, available as oyster planting grounds, are more favorable to the propagation of minute life than the open bay or creeks, where the temperature is lower and less constant. Practically, this is found to be true. For oystermen seem to be generally agreed that oysters "fatten" more rapidly, that is, feed more liberally in the head-waters, blind extremities of the creeks, than elsewhere. This notion of the oystermen is in agreement with my own observations during the past year. Oystermen also assert that oysters "fatten" more rapidly in shallow waters than in deep ones, a point upon which I made but few observations, but such as I did make tended to confirm such an opinion. In illustration I may contrast the condition of the oysters in the pond leased by the Commission at St. Jerome's and those dredged off Pt. Lookout in 20 or 30 feet of water, on the 3d day of October, 1880. The oysters in the pond, by the middle or end of September, were in good condition as to flesh and marketable, while those from deeper water off Pt. Lookout and but little later in the season, were still extremely poor, thin and watery and utterly unfit for market. These differences in condition, it seems to me, are to be attributed in a great measure to differences of temperature and the abundance of food, but mainly to the latter.

THE OYSTER CRAB AS MESSMATE AND PURVEYOR.

It is many years since Mr. Say named the little oyster-crab of our coasts *Pinnotheres ostreum*, and its habits in relation to the oyster seem to have excited but little interest, especially in foreign writers. Prof. Verrill, in his report to the U. S. Fish Commission, observes that it is the female which lives in the oyster, and that the male which is smaller and quite unlike the female, is rarely, if ever seen to occur, but that it has been seen by him swimming at the surface of the water in the middle of Vineyard Sound. His statement that it occurs wherever oysters occur, I cannot agree with, since out of many hundreds of St. Jerome's oysters which I saw opened, I never saw a specimen of *Pinnotheres*; they may occur, but rarely. This little crab has quite a number of allies which inhabit various living mollusks, holothurians, etc., of which admirable accounts are given by Van Beneden in his work on *Animal Parasites and Messmates*.

There can be no doubt that the oyster-crab is a true messmate, and it is highly probable that the presence of these animals in the oyster is rather to be regarded as advantageous than otherwise. The animal lives in the gill cavity of the oyster, and, as will be seen from the following observations, may be the means of indirectly supplying its host with a part of its food. During a reconnoitering trip down the Chesapeake on the yacht "Lookout," in the first week of July last, in dredging, some oysters were hauled up which contained *Pinnotheres*. In the case which I am about to describe, the included crab was a female with the curiously expanded abdomen folded forwards under the thorax and partially covering a huge mass of brownish eggs. Upon examining these eggs what was my astonishment to find that they afforded attachment to a great number of compound colonies of the singular bell animalcule, *Zoöthamnium arbuscultum*. Upon further examination it was found that the legs and back of the animal also afforded points

of attachment for similar colonies and that here and there where some of the individuals of a colony of *Zoöthamnium* had been separated from their stalks, numerous minute rod-like vibriones had affixed themselves by one end. In this way it happens that there is a quadruple commensalism established, since we have the Vibriones fixed and probably nourished from the stalks of the *Zoöthamnium*, while the latter is benefitted by the stream of water drawn in by the cilia of the oyster, and the last feeds itself and its protegé, the crab, from the same food-bearing current. Possibly the crab inside the shell catches and swallows food which in its entire state could not be taken by the oyster, but in any event the small crumbs which would fall from the mouth and claws of the crab would be carried to the mouth of the oyster, so that nothing is wasted. We must consider the crab with its forest of bell animalcules in still another light. Since the animalcules are well fed in their strange position, it is but natural to suppose that they would propagate rapidly. They multiply in two ways, viz.: by dividing both lengthwise and crosswise, one half of the product being set free, and known as swarmers. These cast off germs of the animalcule colonies are no doubt hurried along in the vortex created by the cilia of the gills and palps, carried to the mouth and swallowed as part of the daily allowance of the food of the oyster. We are accordingly obliged to look upon the *Pinnotheres* in this case as a veritable nursery, upon whose body animalcules are continually propagated and set free as part of the food supply of the oyster acting as host to the crab. I do not suppose, however, that such a condition will always be found to obtain, and it must also be remembered that myriads of *Zoöthamnium* colonies were dredged up on algae from the bottom in the immediate vicinity. Such an abundance of germs in the water would favor their being readily transplanted or fixed to the body of the oyster-crab.

NATURAL BANKS.

During my stay at St. Jerome's creek, I examined the natural oyster banks which were readily accessible in shallow water, with gratifying results as to the habits of the animal under virtually undisturbed conditions.—These banks, like those of Europe, always appear to be much longer than wide, but many of them are almost entirely exposed to the air during low tide, a rare occurrence, according to Möbius, with the banks on the Schleswig-Holstein coast of the North Sea. I learned from the owners of some of these banks that, although a considerable proportion of the oysters on them were at times frozen to death during the severe winters, that the fecundity of those which remained was such, combined with the naturally favorable conditions found on the banks for the growth of old and young, as to restore the beds to their wonted productiveness in one or two seasons. Whether this description of the fecundity of the beds found in shallow water is overdrawn or not matters little, since there was the plainest evidence that we had here before our eyes the best natural conditions for the propagation and feeding of the individuals. These beds are, in a word, natural spat collecting grounds; places where such conditions obtain as will allow a large proportion of the swarming brood of the spawning season to affix itself securely and survive in positions where an abundance of food may be got. The tide ebbing and flowing over the beds not only carries with it in suspension the microscopic food best adapted for the nourishment of the oysters, but also tends, owing to the peculiar arrangement of the shells on the banks, to keep the surface of the latter clean, so as to be well adapted as favorable points of attachment for the young.

The oysters assume an approximately vertical position, as shown in the cross-section Fig. 3, of a bank in St. Jerome's Creek owned by Mr. J. W. Wrightson. The assumption of this position seems perfectly natural;

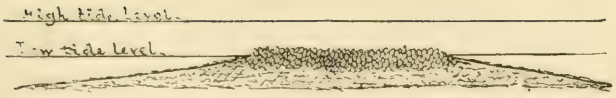


Figure 3.

with the hinge end downwards and the free edges of the valves upwards the animals are in an excellent position to feed while the outside vertical surfaces of the valves are well adapted to afford places of attachment for the "spat." The latter however seems to attach itself in the greatest abundance to the old oysters fixed at the surface of the bank. If one removes oysters from these beds they are found to adhere together in clusters as shown in Figs. 4 and 5. Carefully observing the char-

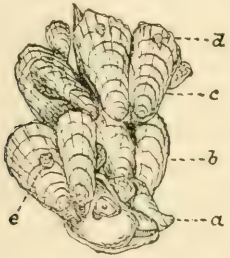


Figure 4.

Figure 5.

acters presented by these masses, it is soon noticed that they consist of a series of generations which have grown one upon the other. In Fig. 4 four generations may easily be made out, as indicated by the letters *a*, *b*, *c*, *d*: in ascending order the oldest generation *a*, is represented by dead shells, which are buried in a black, sandy material, which has acquired solidity from the large quantity of imbedded dead shells which it contains. Attached to the upper edges of the dead valves of *a* follows generation *b*, which consists in part of living and in part of the shells of dead animals ; on the preceding the living uppermost generation *c* is fixed, which affords attachment to a generation of young *d*, though where there are open cavities the lower generations may bear

spat as indicated at *e*. Whether it is proper to regard the superimposed series of individuals as generations may be questioned, but as no more expressive word occurs to me, I wish to be understood as using it here with qualifications.

The "spat," upon careful examination of these beds, we learn does not fix itself in any constant position ; in some cases the young may have the hinge of the shell directed downwards, upwards, or to the right or left hand. Curiously enough the shells do not grow in the directions in which the free edges of the valves are made to assume in the young. Should the young happen to be fixed hinge downwards the free edges of the valves grow directly upwards; in case the hinge is directed either to the right or to the left the layers of lime will be deposited in such a way upon one side as to cause the free edges of the valves to be eventually directed upwards, causing the umbonal portion of the valves to describe an arc of 90°. In case the hinge is at first directed upwards the layers of carbonate of lime will be deposited in such a way by the mantle as to bring the mouth of the shell upwards as shown in the individual *a* Fig. 5. The attempt to get into a vertical position has only been partially successful however, in this last case, since the arc of 180° seems a little too much to be traversed in this way, even by the wonderful persistence of effort of the inhabitant. This struggle to assume the upright position is shown by the curved umbos and lines of growth in other individuals, both old and young, as indicated in the cases of *b c*, Fig 5. The habit of growing in the erect position, where the banks are prolific and undisturbed causes the individuals to be very much crowded together, so that they do not have a chance to expand laterally. From this cause the individual oysters become very narrow and greatly elongated ; the peculiar forms which result are known as "cat's-tongues" amongst oystermen, probably from a sugges-

tive resemblance in shape to the tongue of a cat.* Dr. C. A. White informs me that he has noticed oysters in the fossil state, which occupied a vertical position in a sandy matrix, a fact which shows that the habit so strongly marked in modern banks must be a very ancient one.

All the observant writers upon the oyster agree that it is essential that the bottom upon which oyster banks are to be permanent should not be liable to shift or be covered by mud or sediment carried to the beds by the tide waters. The comparatively meagre experience which the writer has had has strongly enforced such a conclusion. The permanent banks, owing to the great number of dead shells scattered through the bottom soil upon which they have been established, acquire a peculiar solidity or fixedness which the currents of tide water cannot sensibly affect. When once these banks are covered by the clusters of oysters more or less, securely held together by the lower portions being imbedded in the soil below, and mutually wedged together by the many surfaces of contiguous clusters becoming neatly adapted to each other by pressure, it is a very hard matter for the tides to smother the bank unless sufficient soil in suspension is carried by the waters to completely cover the animals. The inferences to be drawn from the foregoing studies are very important. They lead naturally to the inquiry whether artificial oyster beds cannot at least be established in shallow water, where the difficulties in altering the character of the bottom so as to adapt it to the wants of the oyster, are not practically insurmountable. I believe that the establishment of artificial beds in a moderately rapid tide way is possible. The localities, I apprehend, are abundant along both the eastern and western shores of the Chesapeake, and I

*The crowded condition of the banks may be inferred from the fact that as many as 40 oysters were counted by me in an area included in a quadrangle of wire including exactly one square foot; 30 individuals to the square foot was a fair average on the bank examined. Where the "cat's-tongues" are developed, a much more crowded condition probably prevails.

certainly know of no place where the natural conditions offered are any better for such a project than those of St, Jerome's Creek. The bottom would of course have to undergo such preparation as would insure to it solidity, and it might be well to imitate the flat ridge-like character of the bank as shown in Fig. 3. The long axis of the beds should probably lie transversely to the direction in which the tide ebbs and flows in and out of the creeks, as appears to be the case in all the banks examined. The next thing to do would be to colonize these banks with oysters stuck thickly into the bottom, hinge downwards, imitating the position of the animals in the natural banks. The cost of an experimental bank established as I have suggested, need not be much, as the experiment could be tried as successfully on a limited scale as upon a more extensive one.

WHY DREDGING INJURES THE BEDS.

Dredging, inasmuch as it destroys the arrangement of the oysters of the banks, tends to interfere with the fecundity of the latter. Carry on dredging operations on any given bank long enough to rob it both of its natural growth of adult oysters and in part of its natural growth of spat, it would be strange indeed if it did not cease to be productive. As we had occasion to remark above, that the uppermost tier or last generation of oysters was the one which afforded for the most part the points of attachment for the young fry, it is clear that the banks are annually robbed of vast numbers of possible oysters. True, the dead shells which are or ought to be allowed to remain on the beds, lying about amongst the living individuals also afford attachment for the young, but perhaps not more liberally than the living shells.

Another reason why dredging, especially when carried to excess, tends to destroy the banks, as insisted upon by Mobius and others, is the removal by that means of too large a proportion of germ-producing adul It is in this way that the power of the beds to regain their

productiveness is enfeebled or destroyed. Amongst the oystermen there seems to be a widespread indifference in regard to this matter, but it is to be hoped that these persons, who, more than any other class, are directly interested in the maintenance of the productiveness of the beds, will see the evils of excessive or indiscriminate dredging before it is too late to repair the damage done thereby.

The following propositions which have been laid down by Prof. Möbius, are as applicable to the conservation of our own species as to that of Europe :—

"An oyster bank will yield permanently the greatest profit if it possesses such a stock of full grown oysters as will be sufficient to maintain the fecundity of the bank in accordance with its bioconotic conditions.

"When the natural conditions will admit of it, the yielding capacity of an oyster bed may be increased by improving and enlarging the ground for the reception of the young brood.

"The natural banks should be improved by removing the weeds and plants with dredges and properly constructed harrows, and by scattering the shells of oysters and other mollusks over the bottom.

"When circumstances will permit, all the animals which are taken in the dredge, and which kill the oysters or use up their food, should be destroyed.

"It would be much more judicious and much better for consumers, if the 'close time' could be extended until the 15th of September or the 1st of October, so as to allow the oysters some time after the expulsion of the contents of the generative organs to become fat before being brought to the table.

"If it is desired that the oyster banks should remain of general advantage to the public and a permanent source of profit to the inhabitants of the coast, the number of oysters taken from the beds yearly must not depend upon the demands of the consumer or be governed by high

prices, but should be solely regulated by the amount of increase upon the beds.

"The preservation of the oyster beds is as much a question of statesmanship as the preservation of forests."

The foregoing suggestions, emanating from such high authority, serve to enforce what has been said in relation to dredging and the constitution of the banks and their extension. The possibilities which seem to await development along the shores of Virginia and Maryland at the hands of enterprising oyster-culturists are almost limitless, unless, as may be the case, given areas of waters adapted to their culture, will afford food for only a given number of oysters.

FAUNA OF THE OYSTER BEDS.

The animal forms which are encountered on the oyster beds and in the surrounding waters are exceedingly numerous, and range in size from the most minute monads, Vibriones and Bacteria up to fishes and other types of considerable size. Whether the Sheep's-head *Archosargus probatocephalus*, frequents the oyster beds or not I do not positively know, but I strongly suspect that it does. My reason for this belief is that I find the half digested remains of the common branching, crimson-colored sponge *Microciona prolifera*m in their stomachs, together with the crushed shells of mussels (*Modiolaria* and *Mytilus*.) These last can be best obtained by the fish from submerged rocks to which they are attached, but the sponge which grows in considerable abundance on the oyster beds would attract these animals, where they might do some damage to young oysters with their powerful cutting and grinding teeth. Other fishes are found on the banks such as the sole, *Achirus lineatus*, the true toad fish *Batrachus tau;* the outer gill openings of the latter were usually surrounded by a phalanx of parasitic crustaceans nearly allied to the genus *Caligus*, provided with a pair of discoidal suckers on the forepart of the under side of the body. Puffers (called "toads"

on the Chesapeake,) were also noticed, of two species, belonging to the genera *Chilomycterus* and *Chilichthys*. Though the *Batrachus* is also called the oyster-fish, but in opening a number to examine the contents of their stomachs I found no evidence of the remains of oysters, nor does the conformation of the mouth indicate that the fish is in the habit of destroying oysters for food. The teeth of the puffers look as if they might be much better adapted to crush the shells of live oysters, especially those not over a year old. In the Museum of the Academy of Natural Sciences of Philadelphia there is a specimen of a blenny 3¼ inches in length, which was taken from an oyster 4½ inches long by Mr. C. W. Hyatt. On the inner face of both valves the fish, which is apparently a female, has laid its eggs, which are adherent, and cover nearly half the inside of both valves. Although this specimen is interesting and somewhat puzzling, I do not think that the little fish can be accused of destroying the oyster in order to make a comfortable spawning nest for itself. It seems very likely that the animal of the oyster was destroyed in some other way, and that the blenny finding the shell abandoned made it the repository for its eggs, which seem to be partially embedded in a layer of some whitish secretion.

Prof. Möbius alludes to the observation of Captain Johnston, who says, in the Report on the Oyster Fisheries, made to the House of Commons, 1876, that he saw small fishes of the genera *Gobius* and *Mullus* swallow the brood of the oyster as the latter discharged it from its parted valves, and that he afterwards caught and opened the stomachs of the fishes and found the fry in them. Since our oyster discharges its eggs directly into the water before development, when they measure only one five hundredth of an inch in diameter, I think we will not need to be alarmed about the destruction of embryos by small fishes, since I know of no species which frequents the oyster beds whose gill-rakers are close enough

together to catch and hold an object as small as this.

Ascidians or tunicates were quite common and they appeared to be of but one species; one of the smooth forms of *Molgula*.

A single specimen of a small star-fish was met with. Some Pycnogonids and marine mites were noticed but not identified. Crustacea were present in great abundance, the large edible crab *Callinectes hastatus* was abundant and a few individuals were seen which were in the megalops stage of growth. Species of the genera *Sesarma* and *Gelasimus* were abundant amongst the grass along the shores of the creeks and inlets. Amphipods or sand hoppers were abundant and a number of other smaller forms were occasionally picked up while using a fine net, as well as the larvae of fish-lice (*Cymothoids*) swimming about actively in the water. The *Copepoda* were very numerous and appeared to be the principal cause of the luminosity of the water when the net or a stick was made to move through it quickly. It was these, possibly, that the Menhaden was straining out of the water as food, by means of its seive-like gill-rakers, for I always saw these fishes swimming along with their mouths held constantly open.

The entoproctous bryozoan *Pedicellina americana* Leidy, was very abundant in the pond leased by the Commissioners for the work of artificial oyster culture. Prof. Leidy, however, has either described another species than this one noticed by me, or else he has placed the stomach in a position the reverse of what it occupies in nature. The various species of ectoproctous forms I did not have the means at hand to identify; some of the creeping branched forms were common as well as a number of encrusting species.

Annelids allied to the genus *Meckelia* were found in abundance, creeping around inside of the large tubular efferent openings of a pale yellow incrusting and also massive siliceous sponge, the spicules of which were

knobbed at each end. Nereids were common, of moderate size, and an exceedingly slender *Oligochaetous* worm, bright red in color, was dug up out of the sand, several inches below the surface. Planarians were quite frequently noticed creeping over the surfaces of the slate collectors.

Amongst the lamellibranchiates noticed as inhabiting St. Jerome's creek, besides the oyster, was a very destructive boring mollusk related to the true ship-worm, but generally considered to represent another genus, *Xylotrya fimbriata*. So rapidly does this creature bore into wood immersed in the sea that a small pine hatching-box which I had placed in the tide-way to retain impregnated oyster-eggs, was almost destroyed in the short space of 51 days. This mollusk is found at work at the heads of the creeks, where the water is sometimes slightly brackish, just as industriously as elsewhere. The ova, which, according to my observations, are almost identically of the same appearance and size as those of the oyster and soft-shelled clam, are produced by the animals in vast numbers and set free into the surrounding water, where they are apparently fertilized by contact with the male cells set free by the males. The embryos develop rapidly, swim about and soon find a place to fix themselves on some piece of wood in great numbers, when the work of destruction begins. These animals, in the creeks and inlets of the Chesapeake, will no doubt cause considerable trouble to oyster-culturists in destroying the lumber used in making the collectors, nurseries and other apparatus used in conducting such work.

Solecurtus gibbus is found in the sandy flats along with a species of the *Tellinidae*, where the *Mya arenaria* also abounds, which is used extensively as bait for taking the sheep's-head. The spawning season of the *Mya* is short, and begins in the early part of September and lasts until the first or second week of October. During September the large visceral mass in the middle of the shell cavity

greatly and rapidly enlarges, and at this time is considered to be in good condition, or "fat," as the fishermen say. This increase in the size of the body or visceral mass is entirely due to the rapid growth of the generative organs and the ripening of the products in them. The process of coming into condition is, then, just the reverse of what occurs in the oyster. The sexes are distinct, since I never found anything except ova in the females, or spermatozoa in the males. The head of the spermatozoan differs from that of the oyster in being elongated. The number of ova set free by an adult female, judging from the relatively enormous bulk of the ovaries, must be very great, and since the eggs are of exactly the same size as those of the oyster, 1-500th inch, it is not at all improbable that there may be as many as 100,000,000 matured. I succeeded in impregnating the eggs artificially on the 13th of September last, and watched their development until the gastrula stage had been reached, when my observations came abruptly to an end.

The importance and value of this delicious mollusk is hardly appreciated on the Southern coast as it should be, and it appears to me that the artificial culture of it should be almost as much of an object as that of the oyster, with which it will compare very favorably when properly served at table.

The mussels inhabiting St. Jerome's Creek appeared to belong to the genus *Modiolaria*; no true *Mytilus* being noticed.

A few Gasteropods were noticed, consisting of three species of nudibranchiates—(without shells,) and a few very small univalves, the only larger univalve was *Littorina irrorata*, which was very common, sticking by means of the foot to the stems of the tall grass fringing the shores of the creeks. No species of boring mollusk was noticed in the waters of St. Jerome's, so that oyster-culture may probably be conducted there without harm from the *Urosalpinx*, or "drill" as it is called. There

is no doubt however about their existence in some other parts of the bay. Slipper limpets were frequently observed adherent to the outside of oyster shells, the only species though, which I observed, was the one called *Crepidula glauca*. The unripe eggs of this animal have a very remarkable structure, the nucleus containing a large and very refringent nucleolus which looks like two spheres partially fused together, from this body to the walls of the nucleus granular protoplasmic lines extend in a very irregular radiating manner. These granular lines sway and twist about while the fresh egg is viewed under the microscope, like a spider's web, which may be supposed to have been endowed with life and the power of moving any part of itself. E. Van Beneden and O. Hertwig figure very similar immature ova occurring in other animals.

A number of sponges were observed; all of them siliceous; some of them incrusting stones and oyster shells, others were branching or massive and usually of a yellow, yellowish or dirty white color, except some leather sponges (*Geodia?*) which were purplish and anchored in a most remarkable manner to the bottom. The red-sponge, *Microciona prolifernm* is very common, but the species which most concerns the oyster culturist is the boring sponge, the substance of which is deep orange in color. The boring sponges, *Cliona*, are very destructive, but whether they really destroy many living oysters in this country is probably not ascertained. That they can effect the destruction of the oyster there can be no doubt from the following which I published over a year and a half ago elsewhere.* "In a specimen of the common "*Ostrea virginiana*, recently handed me for examina- "tion by my friend Mr. John Ford, the substance of the "shell was thoroughly cavernated so as to render it ex- "tremely brittle and readily crushed; in fact the inner "table of the shell left standing showed a great number

*On the Destructive Nature of the Boring Sponge, etc. Am. Naturalist, XIII. 1879, p. 281.

"of elevations within, which indicated points where the "intruding parasite had been kept out by the oyster "which had deposited new layers of calcareous matter "at these places so as to give rise to the elevations spoken "of. Besides this, the inner table had become so weak-"ened at the insertion of the adductor muscles that the "animal in closing had broken a part of it loose, the "break having been repaired by the deposition of a "brown horny substance." In such cases, as I have just described, it is clear that serious damage may be done to the insertion of the adductor muscle, the perfect integrity of which and power to close the valves must be maintained, or there is a possibility that the oyster may be invaded by some hungry carnivorous neighbor and have its vitals eaten away without being able to shut out the intruder. In buying "plants" it would probably be best to select only such cargoes of oysters as appear to have clean unbored shells, or such as are not "worm-eaten," since I am told by a practical oysterman, Mr. J. W. Wrightson, that a bed once planted with oysters which are badly infested with *Cliona* or the boring sponge, are apt to remain so for some time and that the beds adjoining became infested for the reason that the embryo sponges which are thrown off in large numbers from the infested "plants," swim about in the water, attach themselves to other oysters commence to grow and to bore.

The protozoan fauna of St. Jerome's Creek presents considerable variety; three species of test-building *Cothurnia* were noticed, one *Vaginicola*, three species of *Vorticella* or bell-animalcules, free swimming *Euplotes*, *Nassulas*; of the latter type an exceedingly elongate form was noticed, with a body almost as slender as a thread-worm. Monads were sometimes noted in profusion, though some of these may have been the spores of algae. Amoeboid forms were very few, and the only one which was frequently noticed was a form so nearly

like *Actinophrys sol* that I would pronounce it the same.

The *Freia producta* Wright, was most common; this creature is related to the fresh-water trumpet animalcules, and is one of the most beautiful protozoans I have ever seen. I reproduce here, with some changes, my description of the Chesapeake form from the American Naturalist for November, 1880. "The tubes in which "the animalcules reside are formed of a narrow trans- "parent ribbon of horny consistency, wound into a spir- "al and terminating in a trumpet-shaped extremity from "which the odd peristome of the inhabitant protrudes. "The basal or attached end is usually bent at an angle "to the tube and bears a striking resemblance to the "foot end of a stocking resting upon the sole. This por- "tion is not composed, like the tube, of a spiral ribbon, "but is simply a thin-walled sac, from the open-end of "which the ribbon takes its rise, but it is composed of "the same kind of material. Many of the tubes show a "trumpet-like rim projecting from the sides of the form- "er, a little above the middle, and of the same form as "the terminal rim, showing that this, like the form de- "scribed by Mr. Wright from British waters, may stop "building its tube for a time and then recommence.

"The adult animal tube and all, when fully extended "will measure 1-25 of an inch in length. It is of the "same color as *Stentor caruleus*, or bottle green, but has "the power of elongating and twisting itself as greatly as "*S. roeseli*. The peristome is quite unlike that of *Freia* "*ampulla*, and bears a strong likeness to the blades of a "pair of obstetrical forceps. The blades are deeply "grooved, forming a deep ciliated demi-canal with paral- "lel saides, and at the junction of their bases lies the "spacious, twisted and spirally ciliated pharynx, which "is bounded dorsally and ventrally by the prominent "folds which unite on either side with the long curved "lobes of the peristome. There is a small basal disc "as in *Stentor*, and the ectosarc is traversed as in that

"genus by parallel granular bands, regarded as muscu-
"lar fibers by some writers. The usual food-balls and
"vacuoles are present, and I was enabled to define
"sharply the endosarc from the ectosarc, and clearly
"see the long, beaded nucleus. The tube or ribbon-
"secreting organ described by Wright I was unable to
"discover.

"When fully extended the basal portion of the animal
"becomes attenuated to a thin bluish filament, which
"widens towards the peristome, where the body is over
"half as thick as the inside diameter of the tube. When
"fully retracted and resting, the animal resembles in its
"oblong shape a retracted and resting *Stentor*, and meas-
"ures about 1-10 as long as when fully extended. The
"ribbon which forms the tube makes from four to twenty-
"four turns in specimens of different ages."

THE FAUNÆ OF OYSTER BEDS AS INTERDEPENDENT COMMUNITIES.

Möbius calls an oyster bank a *Biocoenosis* or interdependent community of life. The many species of animals found on the banks and beds are no doubt more or less mutually dependent upon each other for subsistence, but this is perhaps not any more true of oyster banks than it is of terrestrial faunæ. There are no doubt vast numbers of floating embryos of oysters eaten by other animals growing on the beds which bring their food supply to themselves by means of currents produced by ciliary motion. On the other hand there are no doubt vast numbers of the minute swimming embryos of these, drawn in and swallowed by the oyster, which may indeed, for aught we know, in this way swallow many of its own young, for the current produced by the oyster by means of the cilia clothing its gills is by no means a feeble one, though it is exceeded in power by the current flowing into and out of the siphons of *Mya*. In the latter I have frequently, upon opening the animal, found several *Copepoda* plainly visible to the naked eye swimming about in the water in the

inferior mantle cavity, which had evidently been drawn in by the inward current. It is plain in this case that very mild means may become effective as prehensile and destructive agents, so as to bring remotely related types into intimate vital relation. Though an animal may be apparently invulnerable on account of the effectiveness of its covering, it cannot emancipate itself from the abiding struggle it has to make to obtain food, no matter how passively it may appear to conduct itself. The oyster has such a character, yet it has been apparent from what has been observed before, that it is entirely dependent for a vigorous existence upon the favorableness of surrounding conditions. The beds and banks in a true sense are interdependent communities, whose vigor may no doubt be impaired by the removal of a single one of its members. Suppose we should take away the algae, diatoms, oyster crabs, vibriones, bacteria, infusoria, in fact all the minute life, we should greatly impair if not destroy the vitality of the beds. While it is true that many of even the smallest forms may destroy food which should properly be consumed by the oyster, that were it not for the presence of these same small forms some destructive element might attain such a development as to be more injurious still. There is therefore no doubt but that a delicate balance of power is maintained by these rivals which is best for the health of the community. The stability of permanent oyster beds, it must be remembered, furnishes the right conditions for the survival of many types. It is a place where they find both a home and plenty of food. It is the very favorableness offered by these places which tends to induce them to congregate and multiply, and it becomes a serious question whether the artificial establishment of banks will not in time cause the proper types to congregate and multiply so as to afford the needed food supply for the oysters. That destructive members of the community may also be attracted is admitted, but if the beds are established in shallow waters, as I have

previously suggested, the destruction of such unwelcome intruders may be very readily effected. "Drills" and boring sponges are naturally to be thought of as types which should be destroyed, while diatoms, infusoria, small polyps, bryozoa, minute algae, etc., are to be favored in every way. Those forms again, which the oyster-culturist knows are there only for the purpose of getting a good living with little trouble to themselves, ought to be destroyed.

It might be an advantage to introduce certain desirable forms onto a bank, which might be supposed to be useful as a food supply. Infusoria and diatoms not previously existing might be introduced in this way; this, I think, would be especially easy in the case of the former where the type was one which is fixed during its adult life.

METHODS OF COLLECTING AND COLLECTING APPARATUS.

Not having reached the field until the 19th of July, I did not succeed in testing the various collectors, which were for the most part modelled after those in use in France, as thoroughly as I desired. Roofing slates, tiles, shingles, oyster shells and pine cones were used to afford attachment to the young fry of the oyster; in all cases the apparatus was of course submerged, but was not allowed to sink low enough so as to be in contact with or partially buried in the mud. The most successful apparatus used was the various modifications of the slate collector, and which in practice will probably be found the most satisfactory in the long run. We first coated the slates with a mixture of lime and sand, mixed in sea-water, thick enough to cover the surfaces when dipped into the mixture with a pretty thick layer; an eighth of an inch is not too much, so that when the young fry has attained a considerable size it may be removed without injury along with the coating of mortar, a method first introduced in Europe by Dr. Kemmerer, though he used

another composition. The coating should be made of a good strong mortar, about one part of lime to two of sand, and after it is applied it should be allowed to set for several days under cover before the prepared slates are made up into series in frames of various sizes and put into the water. Cement alone does not answer the purpose, as it becomes so extremely hard in the course of time that it cannot be readily removed from the surfaces to which it has been applied, which of course renders it practically useless. The slates after they are prepared were fastened into frames about two feet high, the ends being let into notches about an inch or so apart. In this way a dozen could be made up into one frame, which held them horizontally at a good distance from the bottom and far enough apart to allow the water to pass readily through between the slates, giving the floating embryos a good chance to fix themselves to the mortared surfaces. Other frames were made of an oblong shape, one foot wide and six or eight feet long, the edges of the long side pieces were deeply notched with the saw every three or four inches apart to receive the one edge of a slate, which was held in a vertical position when the frame was laid down horizontally. Some of these frames would hold twelve or fourteen slates in position at once. In other cases the slates were simply coated with mortar and laid in rows horizontally upon parallel poles supported above the bottom a few inches. In other cases again the slates were suspended upon galvanized wire by the four corners, in a tier of 4 or 5, about an inch apart. I also suspended them singly by means of galvanized wire. I did not however obtain the same results from all of the apparatus. The conditions were such however in most cases as to make it extremely difficult to make a fair comparison. Where the slates were in a horizontal position more mud seemed to be deposited on the upper side which interfered with the attachment of the spat on that side, while the comparative shade below

and freedom from mud seemed to favor the fixation of the fry. The slates which occupied a vertical position did not as a whole yield results as satisfactory as those which were placed flatwise.

The tiles were not received in time to make a thorough trial, but they seem to be well adapted to retain their coating of mortar, so far as I have been able to judge from a dozen put into the water in the early part of October.

Shingles will not be adapted to the work, unless they can be protected in some way from the ravages of the ship-worm, as they will not last more than one season at the utmost, even though they were coated with mortar. The difficulty in fastening the shingles together is much greater than in arranging the slates, which also have the merit of being indestructible if properly cared for.

Chaplets of oyster shells were also tried; the shells were taken, a hole punched through the centre and strung upon galvanized wire. This form must be supported upon a framework or suspended to stakes, as the strings of shells are heavy and very quickly sink to the bottom. They have the merit of being cheaply made since the only thing it is necessary to buy is the wire, which costs but a trifle. I am told by Maj. Ferguson that this type of collector is very effective as used in practice by the French. Other shells will answer the same purpose, such as those of the white clam, etc.— Another form which was suggested by my assistant, Mr. W. P. Sauerhoff, has the advantage of being bouyant. This type was made of pine cones, of which we could obtain an abundance near the pond. They were strung on wire in the form of chaplets, six or eight of which were fastened at one end to a stake and weighted down at the other, and arranged so as to radiate like the spokes of a wheel from the stake. The cones however tend to accumulate mud which lodges between the scales; their effectiveness was not determined, since they were

unintentionally placed in a rather unfavorable position.

Brush or fagots have not given the best results, as collecting apparatus they are apparently ineffectual where there is much sediment in the water, and appear to be more effective in places were the water is in rather active motion. I have been informed however, by an old oysterman, that pine bushes stuck securely into the bottom in dense lines have been found very effectual, so much so that an oyster planter following this plan had the satisfaction of seeing the bushes loaded with "spat," much of which afterwards grew to marketable size. Thick palisades might be constructed of brush stuck into the bottom near permanent oyster-banks, with good results; indeed, I do not doubt but that banks might in some cases be established by this method, if, in addition, oyster shells or stones were strewn on the bottom along either side of the brush palisade, in order to afford a foundation for the fixation of the first generations of oysters.

FLOATING COLLECTORS.

Although I have not tried any form of floating collector with much show of success, for theoretical reasons it is a form which should not be left out of consideration. After my experiments with impregnated eggs in floating boxes, some of the latter were abandoned, and upon these and the bottoms of our flat boats young oysters fixed themselves, though not more numerously than upon the slate collectors. Probably the clean black surface of the bottoms of the boats was a favorable place for "spat" to attach itself.

A form which suggests itself to me could be very simply and cheaply made. I would use common plastering laths, which should be nailed together in a simple way, say in frames two or three feet square, with the laths an inch and a half apart. Then these frames should be dipped into a mortar the same as the slates and coated with a pretty thick layer from which the attached "spat"

would be readily freed. These frames I would then have arranged in lines or series with wooden floats, moored close to an oyster bank, in order that the floating embryos from these banks might the more readily find places on the surfaces of the frames to fix themselves.

Floating shingles thinly coated with cement as a protection against the ship-worm, fastened together with wire so as to form large squares, might also be used in the same situations with good results. The ship-worm might be allowed to destroy the shingles as they would still answer the purpose long enough to allow the "spat" to acquire a considerable size, and afterwards be easily broken up when it became desirable to use the "spat" in the "nurseries" or as "plants." But such a practice if long continued might prove disadvantageous, inasmuch as the cultivation of the ship-worm would also be effected, a business not at all profitable where other submerged wooden structures were in use which it was desirable to protect from this destructive creature.

The only advantages to be secured by the use of floating collectors would be in providing a means for floating embryos to fix themselves. Whether the free swimming embryo oysters will really affix themselves more freely to a floating apparatus can of course only be determined by experiment. At times it seemed to me that the collectors which had been placed nearest the surface had caught the most fry, in other cases this seemed not to be the case. There remains enough evidence however to make it desirable that this plan should be thoroughly tested.

THE BOX-COLLECTOR.

The box-collector in use in France is a rough box three feet wide, six long and two and a half deep; it is provided inside with a tier of three trays at each end nearly three feet square; upon these trays are placed dead oyster shells and a few live, spawning oysters. This was essentially the form used by me in my experi-

ments in St. Jerome's Creek. Unfortunately, however, my experience was very adverse with this apparatus, for the reason that the sediment in the water, being carried through the openings in the sides of the box, was deposited on the shells and trays, until, in a few weeks, it had attained a depth in some places of two or three inches. Upon making an examination of the box to see if any "spat" had attached itself to the old oysters, the dead shells or the boards, I found the search useless. The mud seemed to have completely covered all the places which should have afforded points of attachment for young oysters. The live adult oysters however were found to be in magnificent condition in the latter part of September, for every available square inch of vertical board surface, or of such shells as remained clean, was covered with a forest of minute organisms, such as bryozoa, infusoria and diatoms, so that the cause of the good condition of the adults was very apparent. The probability is though, that had the pond been provided with a gate to stop the ebb and flow of the tide, that the sediment would have subsided to the bottom, and not have accumulated in the box and over its contents. Under better conditions the performance of this apparatus would no doubt have been admirable.

The use of straw-mat collectors in the same place was attended with the same difficulties as in using the box. The mats, which were made of small bunches of straw held together with a warp of galvanized wire placed every six inches apart, were so loaded with deposits of mud as to entirely prevent young oysters from attaching themselves.

MUD.

The origin of the black ooze at the bottom of our experimental pond can be traced directly to the sediment held in suspension in the water which slowly ebbs and flows in and out of the enclosure, carrying with it in its going and coming a great deal of light organic and inor-

ganic débris, the former part of which is mainly derived from the comminuted fragments of plants growing in the creek. This seemed to be the true history indicated by what was noticed in studying the box-collector. The same opinion is held as to the origin of this mud by both Coste and Fraiche in their works on oyster-culture.

There is probably no worse enemy of the oyster-culturist than this very mud or sediment. It accumulates on the bottom of the oyster grounds, where in course of time it may become deep enough to cause serious trouble. Especially is this true of ponds from which the sea ebbs and to which it flows through a narrow channel. The falling leaves from neighboring trees in autumn also contribute to this pollution as well as heavy rains which wash deleterious materials into it.

Adult oysters which are immersed in part in this mud struggle hard to shut it out from their shells. If one will notice the inside of the shells of oysters which have grown in a muddy bottom, it will often be seen that there are blister-like cavities around the edges of the valves filled with mud, or a black material of a similar character. There is not the slightest doubt in my mind that in these cases the animal in order to keep out the intruding mud has had recourse to the only available means at its command. A great many of the oysters in the pond are affected in this manner, but it is extremely uncommon to find shells of this kind in opening oysters coming from a hard bottom. It is easy to understand that such efforts at keeping out the mud from the shell will not only waste the life forces of the animal but also tend to greatly interfere with its growth. The importance, therefore, of artificial preparation is apparent, where it is desirable to establish ponds for the successful culture of this mollusk.

Only in one case have I observed that the mud tended to impair the flavor and color of the oyster. In this instance the animal was thoroughly saturated with the

black ooze, the very tissues seeming to be impregnated with the color, the stomach and intestine loaded to engorgement with the mud, the animal manifesting every sign of being in a decidedly sickened condition. The cause of this was probably that the shell with its tenant had sunken too deeply into the mud when the ingestion of the black ooze commenced, giving rise to the remarkable changes which I have recorded. No doubt had this condition of things persisted for long the animal would have been smothered by the mud.

MUD AND THE YOUNG FRY.

The accumulation of the slightest quantity of sediment around a young oyster would tend to impede its respiration and in that way destroy it, yet, in the natural beds there are so few naturally clean places which remain so, that it is really surprising that so many young oysters pass safely through the critical periods of their lives without succumbing to the smothering effects of mud and sediment. When it is borne in mind that at the time the infant oyster settles down and fixes itself once and for all time to one place from which it has no power to move itself, it measures at the utmost one-eightieth (1-80) of an inch, it will not be hard to understand how easily the little creature can be smothered even by a very small pinch of dirt. The animal, small as it is, must already begin to breath just in the same way as its parents did before it. Like them its gills soon grow as little filaments covered with cilia which cause a tiny current of water to pass in and out of the shell. The reader's imagination may be here allowed to estimate the feeble strength of that little current which is of such vital importance to the tiny oyster, and the ease with which it may be stopped by a very slight accumulation of dirt.—Möbius estimates that each oyster which is born has $\frac{1}{1,145,000}$ of a chance to survive and reach adult age, so numerous and effective are the adverse conditions which

surround the millions of eggs matured by a single female, that only the most trifling fraction ever develop as illustrated by the above calculation. The egg of the oyster being exceedingly small and heavier than water, immediately falls to the bottom upon being set free by the parent. Should the bottom be oozy or composed of sediment its chances of development are meagre indeed. Irrecoverably buried, the eggs do not in all probability have the chance to begin to develop at all. The chances of impregnation are also reduced, because the male and female oysters empty their generative products directly into the surrounding water, whereby the likelihood of the eggs meeting with the male cells becomes diminished. What with falling into the mud and what with a lessened chance of becoming impregnated, it is not unlikely that Möbius' estimate is very nearly correct, but the American oyster whose yield of eggs is much greater, not only on account of its larger size, but also because the eggs are smaller than those of the European, has probably still fewer chances of survival.* The vigorous growth of small organisms on surfaces fitted for the attachment of young oysters also tends to cause sediment to gather in such places in the interstices of the little organic forest where the eggs of the oyster no doubt often become entombed or smothered by the crowded growth surrounding them.

INTERFERENCE OF OTHER ANIMAL LIFE.

We have called attention above to the probable interference of small organic growths to the fixation of the young fry; in practice it is found that the larger organic growths which establish themselvos on the collectors, also become injurious. The two most conspicuous types are the sessile Ascidians or tunicates and the barnacles. I have frequently found fully one-half of the surface of a

*According to estimates which I have made based on the figures of the eggs of *Ostrea edulis* given by M. Davaine, they are 1-130 of an inch in diameter. Estimates based on the figures of Lacaze-Duthiers give 1-270 of an inch, while Möbius estimates the size of the young fry at 1-156 of an inch.

slate covered with a dense colony of ascidians; in this condition a great percentage of available surface is lost which ought to serve for the attachment of spat. The surfaces so occupied would also be comparatively clean were it not for these organisms which actually become a serious annoyance. They, like the oyster, affix themselves to the slates while still in the free swimming larval stage, since the surfaces designed for the oyster are equally well adapted to them. The barnacles which also affix themselves in great numbers become a nuisance for the same reason. The larval barnacle is an extremely active little creature and dashes about in the water with great rapidity. As soon as it has completed this stage of its growth, it betakes itself to some object to the surface of which it attaches itself by the head end, when a singular change takes place, at the end of which it is found that it has begun the construction of the curious conical shell which it inhabits. They grow very rapidly, so that in a couple of months the shell will already measure over half an inch in diameter. In this way farther inroads are made upon the room which should be taken up by oysters.

Of course, the larger types are not alone in taking up space, since infusorious, bryoza, polyps, etc., are also culpable, as well as algae, such as diatoms and the higher forms. The only remedy for this accumulation of animal growths on the surfaces of the slates and other collecting apparatus, will be to have the frames which hold the slate in position so arranged that each tile, shingle or slate can be removed, in order that it may be readily overhauled and these organisms removed from the surfaces which it is desired shall remain clean. This work would have to be done at intervals of every two or three weeks, and should be conducted with great care so as not to remove the oysters which have affixed themselves along with the other things which it is the intention to destroy. The removal of the smaller forms from the surfaces of

the slate would be more difficult and attended with danger to the fry already attached. With this object in view, I would suggest the use of wooden racks or frames lying horizontally, which would receive the slates into deep notches made with a saw, so as to hold them vertically or edgewise, rendering their removal for the purposes of cleansing and their replacement an easy matter. Other devices would no doubt answer the same purpose and be more convenient even than the last. If posts were securely fixed in the bottom eight or ten feet apart, so as to project a foot or so above the water at the highest tide, a single board six inches wide, nailed against the tops of the posts edgewise, and extending from one to the other, would provide a simple arrangement from which to hang the slates singly by means of galvanized wire fastened or hooked to nails partly driven into the board. By the help of this plan one man with a boat could overhaul many hundreds of slates in a single day and effectually care for them for a whole season. This last contrivance would not answer well perhaps where there was a swift current, but would be a most admirable arrangement in still ponds or "claires." In such places the whole area might be provided with posts grouped or placed in rows, so that when the attendant was at work he could pass in order from one row to the other in a narrow boat or two attendants in one boat could take care of two rows, the ones on either hand at the same time.

As it may be concluded from the foregoing, that the writer would have everything removed from the surface of slates except oysters, he would correct this impression. The intention is not to scrub the slates as a housemaid might scrub a floor to remove every speck of dirt, but simply to clear off the animals which are very evidently taking up room to the exclusion of more valued tenants. By some such method as that here described a careful supervision can be accomplished with little out-

lay and every injurious agency can be watched and destroyed before serious damage is done.

DIFFICULTY OF KEEPING ARTIFICIALLY IMPREGNATED EGGS ALIVE.

During my sojourn at St. Jerome's Creek, experiments made with a view to keep the young oysters alive which had developed from artificially impregnated eggs, met with no better success than the attempts previously made by Prof. W. K. Brooks. The difficulties experienced were the same as those encountered by him, that is, it was found impossible to renew the water on the swimming embryos without losing many of them. Whether the mortality experienced is altogether due to the decomposition of organic material, sudden or violent changes of the temperature and weather, or a want of more frequent changes of water, I am not prepared to say. Heavy storms no doubt affect the eggs and embryos very much; sometimes mortally, as Prof. Brooks' experience as well as my own would seem to indicate. Floating boxes with muslin bottoms were tried, but with indifferent success, although the boxes were covered, violent rains seemed to kill the embryos. The muslin bottom which was employed was soon found to become loaded with organic matter and small organisms, so that it soon became practically impervious to water. The development of minute life was rapid, and the sides and bottom on the inside were soon covered with a slime loaded with vibriones, monads and infusoria into which the delicate eggs probably sank to be smothered or consumed as food by this microscopic host. Repetitions of the experiment met with the same bad success, until at the suggestion of Major Ferguson a large flannel pen was constructed into which a quantity of eggs, numbering many millions, were placed. The pen, although so large, 6 feet long, 4 deep and 3 wide, gave results of little more value; though I obtained a single young oyster which fixed itself on

one of the slates suspended by means of wire from strips extending across the top of the box from one side to the other. It seemed to me, however, that there was little doubt but that the single young oyster found on the slate seventeen days after the spawn had been put into the box, was one of the embryos which had been so introduced. The flannel, like the cotton, becomes befouled in a few days with a muddy deposit held together with a disagreeable slimy material: it, like cotton and bolting cloth, rots in a couple of weeks so as to be easily torn by fishes and other water animals, such as musk-rats. Once the enclosure has been invaded by a larger animal forcing its way through the flannel, as happened in the case of the large box, one can no longer be certain that embryos naturally fertilized in the open waters may not have found their way in. The experiment with the large box was useful however, as showing that embryo ascidians and barnacles might be pretty effectually excluded by the use of textile membranes through which the water had to be strained before it could enter the box.

PROPOSED NEW METHODS OF CARING FOR ARTIFICIALLY IMPREGNATED EGGS.

From this season's experience it results that I have but little faith in floating boxes or enclosures of any kind in which cloth is used to keep the eggs or embryos confined. Few cloths are evenly and closely enough woven, if they could be kept clean, to retain in an enclosure eggs as small as the 1-500 of an inch in diameter, which is about the size of those of the oyster, clam, ship-worm and perhaps many more marine animals of various types, such as embryologists would be glad to study, provided they had an apparatus which would enable them to work continuously.

Finding that what we wanted was a device which would enable the operator to change the water on the embryos and eggs continuously and at the same time not

run the slightest risk of losing a single egg from leakage, it occurred to me that the proper thing to do would be to construct a box in which the water passed through a membrane of blotting or filtering paper into the hatching chamber and out of this again through a similar membrane into another chamber and allowed to escape. In some such way it will be possible to hatch the minutest eggs and watch the reproduction, division, etc., of the very minutest monads. The idea is possibly one of immense practical value in oyster-culture and opens up a field of work in embryology in the pursuit of which many conquests are still to be made.

Another form of apparatus which suggested itself to me during my experiments with the device just described, has the advantage of being easily operated by some simple form of pump, by means of which the water may be constantly renewed in the hatching chamber. A metal ring with a bibulous membrane on either face, made water-tight around the edges of the ring, so as to enclose a space into which a short piece of tubing may be screwed at one side and connected with a pump by a rubber tube. In this way, by pumping, water would be drawn into the space included by the ring and membranes, provided these were immersed in the water contained in the hatching chamber. Of course, the membranes would have to be strengthened both inside and outside by a single thickness of stout canvas, the same as I used in making my experimental boxes, so as to have the bibulous membrane between the sheets of canvas to avoid rupturing the former, by pressure or accident. The diameter of the ring and membranes might be six inches, as more than that would probably render the membranes liable to collapse when the pump was in operation. The amount of water passing through the apparatus I should think would not need to be more than what would completely change the water in the hatching chamber once in every half or one hour, so that the pump necessary would be

one of small capacity, working slowly. Probably enough aerated water would pass through the hatching chamber by being changed 24 to 48 times in the course of 24 hours, to ensure the success of this method of artificially incubating the artificially impregnated eggs. Difficulties might be experienced in keeping the membranes from clogging in the practical conduct of the work of incubation by either of the methods which I have proposed, but this could easily be remedied by filtering the water to be passed through the hatching chambers, through moderately coarse cloths, and by carefully keeping the outer canvas covering the membranes clean, and by renewing both canvas and membranes from time to time.

The importance and value of an apparatus by the help of which the oyster may be artificially hatched and taken care of up to the critical period when the young larvae fix themselves, can hardly be over-rated, because if this can be achieved a new lease of life awaits the interests of oyster-culture. There may be difficulties in the way which I have not foreseen, but the importance of the plans proposed and the schemes which depend upon them are so great that I hope to be pardoned for appearing too sanguine in my anticipations of success.

Should success attend experiments made in the way above described, so far as to keep the larvae in a healthy state up to and including the period when they fix themselves, it will be necessary to provide some kind of collecting apparatus which may be placed in the hatching chambers after it is ascertained at what age they are ready for fixation. It may also be necessary some time before the young are ready to attach themselves to provide them with food by passing unfiltered water into the hatching chamber to avoid starving them, from a hose or vessel, without its having passed through the incurrent membrane which filters out both the dirt and the food of the young oysters. The collecting apparatus which has suggested itself to me and which I think might be used

with good results, should be made of small bunches of cotton wool, strips of undyed cloth, bunches of bristles, sheets of mica, and similar materials which would afford temporary attachments for the fry and which afterwards could be separated when ready to be removed to more commodious quarters or artificial nurseries. In order to study the manner in which the fry at first fixes itself, it will doubtless be necessary to use cotton wool, thin strips of mica, or glass. It is only by this means that the true character of the attachment can be learned from the objects themselves, brought on to the stage of the microscope in an entirely undisturbed condition. Beyond the period of fixation it would probably not be judicious to retain the fry in the hatching boxes, because they are now in a condition to feed actively, and should be placed under such conditions in a supply of constantly changing unfiltered water, as will supply them with an abundance of food. This brings us to the consideration of

NURSERIES.

These, I apprehend, would best be made in the form of galvanized wire cages, of $\frac{1}{4}$ inch mesh cloth, inside of which a number of trays might be placed one on top of the other. These trays might in fact be made to answer as supports for the collecting apparatus in the hatching boxes, to be afterwards transferred with the affixed spat to the nursery cages. The greatest care would have to be exercised in the care of the very young fry until it was about ten days old from the time of fixation. No noxious animal growths ought to be permitted to grow upon the trays or collecting apparatus if it is possible to prevent it, nor should the fry be exposed for any great length of time to the air, which would no doubt be very injurious. The cages if totally immersed should be provided with a wire cloth cover with meshes as fine as those of the sides and bottom in order that carnivorous fishes and mollusks may be effectually excluded. After

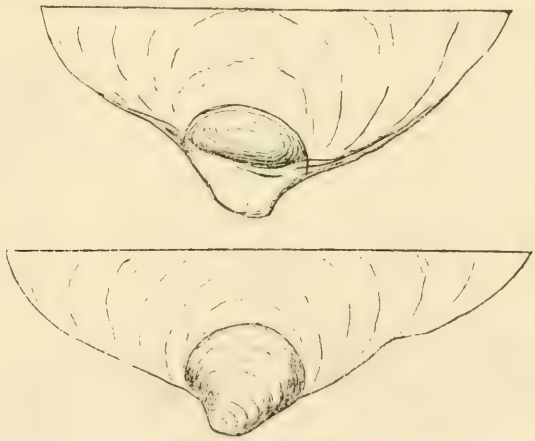
the young have grown to be ¼ to ½ of an inch in diameter they would probably thrive better in a cage made of wire cloths with coarser meshes. Here they should be spread upon trays so as not to encroach upon one another, but the care to keep them from being injured by other growths and enemies should not be abated. Finally, after being cared for until a few months old they would probably be ready to be introduced into the claires or parks, where a clean bottom should be prepared for them upon which they should be spread, so as not to interfere with each other's growth by being crowded too thickly together on the bottom.

The difficulties about the methods just proposed, are their practicability and cheapness which may be found to be insurmountable obstacles in the way of their success upon being brought into practice. And, I have only taken up so much space with a description of my plans in order that some one else may be able to test them should I be prevented from doing so, as well as to point out a new line of experiment looking to the solution of the difficult problem of the cheap and practical artificial cultivation of our noble American oyster.

OBSERVATIONS AS TO THE SIZE OF THE FRY AT THE TIME OF FIXATION.

Upon examining the hinge of young oysters carefully, it will be noticed that at the very apex of the umbo of either valve there is a very small rounded prominence. This upon examination with a magnifying power of fifty diameters is found to show faint lines of growth like the other portions of the shell. It covers like a little cap the extreme tip of the valve and appears to be somewhat raised from the other part of the shell or marked off by a groove which surrounds it. On comparing a great number of young spat we always found these little cap-like tips to the valves, and always of about the same size and shape. Remembering that the young of Gaster-

opod mollusks often in passing into the adult estate cement their larval shell to the tip of the permanent one, it occurred to me that these little cap-like structures on the tips of the umbos of the young oysters, must in like manner be regarded as the shell of the oyster larva at the time it attaches itself to a foreign object. Upon comparing the outlines of the supposed larval shells of our oyster with those shown in a mounted specimen of larval oysters taken from the mantle of the European species, I found the likeness very striking but much larger. These umbonal affixed larval shells measure on the average 1-80 of an inch, which is probably the size of the fry at the time of fixation and are represented in position in Fig. 6 viewed from within, and Fig. 7 from



Figures 6 and 7.

without. Previous to attachment, the right and left shells of both the American and the European species are perfectly symmetrical, and it is not until after attachment takes place that the valves show a disposition to become unlike. These larval shells in the spat I have examined are symmetrical, which is almost positive proof that they are really the temporary shelly covering of the fry when about to change its roving habit to

a stationary one. I never failed to find the structure present, which I have just described, on young spat; after a time, as the oyster becomes older, the umbonal, portion of the shell together with the larval shell is worn off or is dissolved away by the carbonic acid in solution in the water, so that it is not to be found on the adult shell.

In examining the collection of oysters in the museum of the Academy of Natural Sciences of Philadelphia, I found that I could very easily detect the presence of this larval shell, and of about the same size, in the "spat" of four other species, viz: *Ostrea equestris* Say, from Florida; *O. conchaphila*, California; *O. cucullata*, Viti Islands, Pacific; a species which was also bored by a *Cliona*; *O. peruviana*, Peru. The presence of this feature, together with others, will enable conchologists to distinguish the young from adults, some of the former no doubt having supplied a basis upon which to found species.

THE RATE OF GROWTH OF THE SPAT.

Upon comparing the spat obtained from our collectors which were put out in the pond at St. Jerome's Creek, with that of the same age as figured by Coste, and Möbius of the European oyster, I find that our species grows with three or four times the rapidity of the former. For instance, Möbius figures a European oyster twelve to fifteen months old, which measures only 1¼ inches in diameter, contrasting this with the size of the American at 79 to 82 days old and measuring from 1¾ to nearly 2 inches in diameter, we see how immeasurably our species surpasses that of Europe in vigor and rapidity of growth.

Fig. 8

Fig. 8 shows the single specimen obtained from the collectors placed in the large box or flannel pen, and supposed to be one of a lot of artificially impregnated spawn put into the box seventeen

days previously. It was probably not attached longer than from seven to ten days and is already as large as a young European oyster figured by Möbius as being a month old. I have sketched it both natural size and enlarged about three times to show the tiny larval shell as a sort of rounded point at the apex of the upper valve.

Fig. 9.

Fig. 9 shows a young oyster supposed to be not over twenty days old, and the one represented in Fig. 10 is known not to be over 44 days old, Fig. 11 is not over 48, Fig. 12, 79, and Fig. 13, 82 days old. Fig. 14 represents a very fine specimen

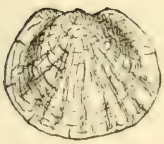


Figure 10.

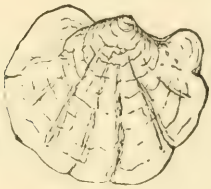


Figure 11.

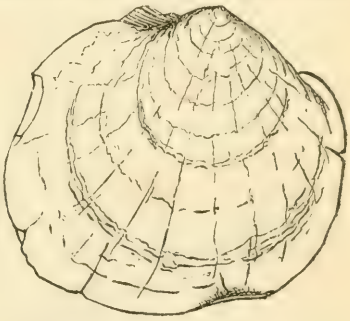


Figure 12.

taken from the inside of a wreck at Cape May, N. J., by my friend Mr. John Ford, and is supposed to be not over

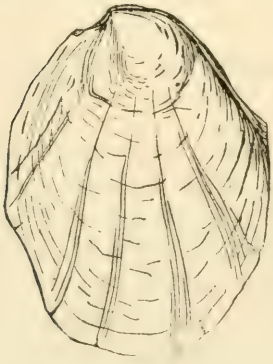


Figure 13.

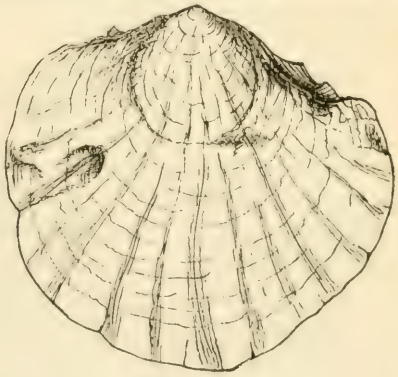


Figure 14.

2½ to 3 months old from the fact that it was collected in

July, while the shell bears every mark to indicate that it probably is of one season's growth, being spawned in the early part of the breeding term.

It will be noticed that all except Fig. 13 are handsomely rounded in shape not unlike a scallop in form, which they simulate still more by the lobes which they develop on the shell on either side of the hinge. Bands of a purplish color also radiate from the hinge, widening towards the margin of the valves, giving the spat a very much more handsome appearance than the adult, from which it differs also in having an extremely thin shell which is easily crushed or broken. The rounded forms were taken from the flat surfaces of the slate collectors, though Fig. 13, the only one noticed which exhibited a tendency to elongate like the adult, was taken from a similar surface. If the fry happens to fix itself to a roughened surface or in an angle it will adapt itself to the shape of the nidus which it has chosen. In one case I found a small oyster about a fourth of an inch in diameter attached to the outside of the plicated shell of a *Modiolaria*, and was surprised to notice that in growing and adapting itself to the wrinkled surface of its host it had reproduced in both valves all the folds on the outside of the former. I also found a specimen which had fixed itself to a dead sponge.

NUMBER OF SPAT WHICH FIX THEMSELVES TO A SINGLE SLATE.

As I have remarked above the most successful collecting apparatus was found to be the slates covered with a coating of mortar, but even these did not give the most promising results, as the greatest number of spat noticed on one slate was 8, varying from ½ to 1 inch in diameter. This meagerness in the number of young which fixed themselves last summer may have been due to an unfavorable season. The results obtained by Captain Winslow as detailed in the report of this Commission for the

season of 1880, were much more satisfactory with half-round tiles. Using hurdles or nests numbering 8 to 16 tiles, the results obtained from one placed in the Big Annemessex were very flattering. After it had been immersed 24 days 1506 oysters were counted; after 45 days 1334; and after 93 days had elapsed the number still adherent was 539. In size and at corresponding ages these were similar to those which fixed themselves to the slates used at St. Jerome's. From what we know of the number which sometimes fix themselves to a single object we may yet look for great successes in the use of collecting apparatus. In one instance, the inner face of one valve of a dead oyster furnished attachment for over 40 spat from $\frac{1}{8}$ to $\frac{3}{8}$ of an inch in diameter.

CHANGES OF FORM DURING THE GROWTH OF THE SHELL.

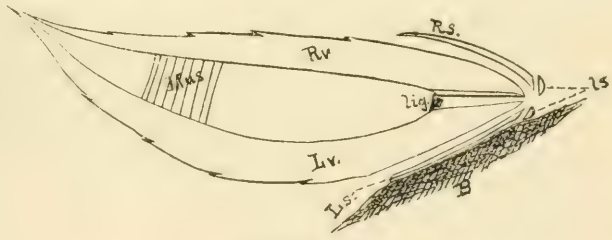


Figure 15.

In Fig. 15 we have attempted to represent the changes of shape and character of the shell of the oyster in passing from the free-swimming larval condition to that of the adult. There are three well marked stages of shell-growth, viz.: (1) the perfectly symmetrical stage attained by the valves of the "fry:" (2) the asymmetrical stage of the "spat," and (3) the asymmetrical form assumed by the valves of the adult. In the figure, which is supposed to be a section of the shell with all its parts preserved, cut through lengthwise from the hinge end to the free edges of the valves, we note first, that the shells of the larva or "fry" *ls.* are alike in cross-section: that the section of the "spat," which has affixed itself to a sta-

tionary basis *B*, shows that the right valves *Rs.* is concave within and convex without, while the attached left valve *Ls.* is flat conformably to the character of the basis of fixation, which is most often of this nature. Contrary to what is noted in regard to the shape of the valves in the "spat," the right valve of the adult *Rv.* is nearly flat, while the left one *Lv.* is most decidedly concave within and convex without. Other changes in the more important parts during growth are manifested mainly by the muscle *Mus.*, which moves the position of the insertions more towards the free edges of the valves, while the ligament *lig.* is moved in the same direction. Other differences in the forms of the valves at the different stages may be noticed: for instance, the shells of the "fry" are deeply concave and very thin, the valves of the "spat" are still also relatively thin, while it is only the adult which has a very thick, stout shell, though the thickness is said to vary with the depth of the water, the thinnest shelled oysters being found in the deepest water. These deep-water oysters are known as "paper-shells" and are not liked by oyster packers and dealers, because the valves break very easily in opening them, causing additional labor in their removal. This last fact is evidence in favor of shallow-water culture.

There are good grounds for dividing the growth of the oyster into the three stages already alluded to: the first we may consider as answering definitely to the free swimming condition or that of the "fry:" the second the thin-shelled primary fixed condition or that of the "spat:" the third, that of the adult, which already has a pretty thick shell when a year old, when the generative organs too are in active functional use, a circumstance which has also been noticed by writers on the life-history of the oyster of Europe.

Introductory Note to Mr. Winslow's Paper.

[This paper is a desirable contribution to the literature of embryology, inasmuch as the observer has been able to follow the development of *Ostrea edulis* from its earliest phases, which has never been done before by any embryologist, although the artificial impregnation of the eggs was attempted by M. Davaine, who says he failed, and that the eggs soon became putrid and the water containing them swarmed with infusoria. M. Davaine's figures bear the marks of having been carefully made from close observations, but he obtained his material from the upper gill chamber, where the ova had already undergone all the changes represented from Figs. 1 to 16 of Brook's drawings of the early stages of the American species. Many things have accordingly escaped the notice of the French author, who did not see the "polar globules;" the first and second periods of rest and activity at all. He also failed to recognize in the embryos with the dorsal saddle-like depression, a blastopore stage and the epibolic invagination of the hypoblast. He, however, finds that the shell originates in the position of the blastopore, as shown by Brooks. He states that the velum atrophies with the development of the mantle and gills; but does not describe the latter. He does not note the presence of a membrane around the ovarian egg, and it seems to me the membrane is a continuation of the vitelline, which forms a stalk by which the ovum is attached to the walls of the follicles of the ovary, making a channel for the passage of plasma for the growth of the ovum, as suggested by Balfour.

Mr. Winslow's paper was first offered to the Maryland Academy of Sciences for publication, but was declined on account of a want of funds to publish it, when it was offered to Maj. Ferguson, one of the Commissioners of Fisheries of Maryland, who accepted it for publication in the annual report of the Commission for 1881. It will be noticed that the author makes no claim as to his ability as an accomplished embryologist, but the observations he has made are very important, as showing that the eggs of *Ostrea edulis* can be artificially fertilized and their development watched the same as our own species.]

J. A. R.

An Account of an Experiment in Artificially Fertilizing the Ova of the European Oyster (Ostrea edulis.)

Having been engaged during the summers of 1878—9 under the direction of the U. S. Coast and Geodetic Survey upon an investigation of the oyster beds of Chesapeake Bay, and having devoted some attention to the biology of the American oyster during those seasons, such study being an incidental and partially a necessary portion of my work, I have been lead, by the interest awakened by my previous labors, and by Dr. Brooks' late successful experiment in artificially impregnating the ova of the American oyster, to attempt a like experiment with the European species. While the vessel to which I am at present attached was off Cadiz, Spain, I was so fortunate as to obtain about one hundred oysters fit for fertilization from the waters of the Bay of Cadiz, and my experiment having been successful beyond my expectations, I have concluded to lay the record of it before the Maryland Academy of Sciences, thinking that any information regarding the oyster, whether of the European or American species, could not fail to be of interest to the Academy. During the summer of 1879 I had the pleasure of witnessing the experiments of Dr. Brooks, which he has detailed in his paper upon the Development of the American Oyster, and with which the Academy is doubtless familiar, and in conducting my own experiment I have followed his method as nearly as possible, and have used his figures in describing the development of the European animal. I can therefore lay no claim to originality in either the conception or execution of the experiment which I undertook, and I am but a follower in Dr. Brooks' footsteps. As however, this is, so far as I am aware, the

first attempt to artificially impregnate the eggs of the European oyster, and as the inferences which can be logically drawn from its success affect the theory of the reproduction of the animal and the development of its eggs to the same extent as those drawn from like successful experiments affect our own species, I have thought my work might prove both of interest and of value.

I labored under many disadvantages, and with a very inferior microscope, though magnifying 300 diameters, of obsolete pattern, and at times had to contend with the irregular motion of a vessel at sea and the deficient light afforded by lamps. All my appliances were such as I could obtain or improvise on board ship, and their rudeness and the inconvenience they caused hampered me a good deal in conducting the experiment. I regret that my observations were not more systematic, regular and frequent, but a naval officer has but few moments which he can safely call his own, and my official duties necessarily compelled my frequent and prolonged absence from the microscope.

HISTORY OF THE EXPERIMENT.

The oysters were obtained from the mouth of St. Mary's River, in the Bay of Cadiz, Spain, and were natives, the variety having existed and flourished in the Bay for as far back as could be remembered. In appearance they were quite similar to the American species (*Ostrea virginiana*), having long shells of from one to three inches in length, rougher and thicker than is usually the case with the European oyster; there were no clusters however, all the animals growing singly, and but a very few young of the previous season were attached to the shells; those noticed were probably nine or ten months old, and though certainly of the brood of the previous season were small sized when compared with the American oyster of the same age. The adults were about the size and

of the appearance of the Chesapeake Bay oyster when about two years old. The animals when divested of their shells were larger than those of the same species from other localities, and were all in good condition, the ova and spermatozoa being ripe, in many cases oozing from the oviducts, and in all cases in admirable condition for artificial fertilization, the eggs being well defined, and with but little granular matter among them, while the spermatozoa were exceedingly active.

I had intended to examine carefully the ovaries, gills and mantles of all the oysters at my disposal with the intention of detecting the existence, should there be any embryos within the shell, but the pressure of other duties and the disadvantages under which I labored left me but little time and few opportunities to devote to the matter, and consequently I am unable to state positively that in some among the limited number in my possession, the embroys were not fostered within the shell of the parent. I was able to examine between twenty and thirty oysters only ; these at least contained no embryos, though some of them were expelling the contents of the generative organs, as I found on the gills of two, ova unimpregnated, and on the gills of another, spermatozoa.

In making the experiment I followed carefully the method of Dr. W. K. Brooks, as described by him in his paper on the development of the American oyster, (Report of the Commissioners of Fisheries of Maryland, 1880,) and I am compelled to refer to his figures, given in that report, from the want of suitable instruments and conveniences for making those of my own. As I carefully followed the development of the eggs through each stage, comparing those under the microscope with the figures at frequent intervals, as the successive stages of development are well marked, and as I have witnessed many of them in company with Dr. Brooks, and have likewise observed them while working independently during the summer of 1879, I think my observations may

be relied upon and assigned a greater value than those of most amateurs.

THE ARTIFICIAL IMPREGNATION OF THE EGG.

Two ripe males were selected, the spermatozoa from which was very active, and the visceral mass was cut out : all parts of the digestive organs were then removed, leaving the generative products in the saucer. The latter were then chopped up as finely as possible and mixed with salt water, and the fragments of the digestive organs, mantles and gills carefully washed out, and this process was repeated several times until the male fluid was free from all deleterious matter. Two female oysters were then treated in a like manner, and finally both male and female fluids were mixed thoroughly in a glass holding one half pint of clean salt water. The fertilization was accomplished at 8.05 P. M. on June 6th. The following are the noted times of the principle changes during the process of segmentation and subsequent development :

8.12 P. M. The eggs were irregular in shape and covered with spermatozoa—germinative vesicle plainly visible—appearance exactly as figured by Brooks. (Report Com. Fisheries, Maryland—Pl. VIII—Fig. 51.

8.32 P. M. Germinative vesicle had disappeared and eggs nearly similar to Brook's fig. 52, though not so regular in outline.

The water was now siphoned off and the glass half filled with fresh sea-water.

10.03 P. M. One hour and fifty-three minutes after fertilization, the eggs had become elongated, and the polar globule was easily observed. In a few eggs the separation of the micromeres and macromeres could be distinguished. The appearance of the eggs was as is shown in Brook's figs. 2, 3, 4 and 5, the larger number resembling figs. 2 and 3.

At 11.10, about three hours after fertilization, all the

eggs examined had passed through the first stage of activity, and as far as could be decided had reached the second period of rest—resembling Brook's figs. 8, 9 and 10. I was called away from the microscope at this time and was unable to trace the changes during the second period of rest or to note the time of their occurrence.

At 1.27 A. M., or five hours and fifteen minutes after fertilization, the eggs had passed through the second period of activity and had entered upon the third period of rest. In some of them the four micromeres were easily observed, but in others they were not so distinct; a few were as figured by Brook's (fig. 16), but the majority appeared as in figs. 18 and 19.

I was unable to follow the intermediate changes between those of the third period of rest and those of the first swimming stage, but at my next observation, at 4.30 A. M., on the 7th, larger numbers of eggs had reached the latter stage and were swimming at the surface of the water. The cilia were well developed and the movements of the embryo very rapid—their appearance was exactly as figured by Brooks' figs., 32, 33, 34 and 35. The water in the glass was now siphoned off, into a jar, that the embryo might have room for development and be free from the influence of decaying eggs; but as I had but two fruit jars holding a quart each, with which to conduct my experiment, I was forced to take many eggs into the second receptacle before they had developed swimming powers, or else sacrifice them. As the rate of segmentation was very irregular, I had for a time, what was to me, a rather confusing mixture of eggs in the process of segmentation and developing embryos; but with care and close observation, I managed to follow each lot until they reached the swimming stage and could observe no difference between them and the first, except in the rate of change from one period to another.

At 12.30 P. M., June 7th, or sixteen and a-half hours after fertilization, there were many eggs in the first swim-

ming stage, but the majority had only reached the later periods of segmentation, appearing as figured by Brooks, in Nos. 25, 26, 27.

At 8.00 P. M., there were large numbers in the first swimming stage at the surface of the water, the cilia were well defined and active; in many cases the polar globule was still observable. The majority of the embryos appeared as figured by Brooks, in Nos. 32, 34 and 35, while a few were in more advanced stages, appearing as in 36 and 37. The pressure of other duties prevented my continuance of the observations after 11 P. M. until 11 A. M. on the 8th. At that time the majority of the embryos were as figured in Nos. 36, 37 and 38, the latter stage predominating. The shell was remarkably well defined in several, but the activity of the embryo and the rudeness of the instrument used, prevented my deciding with certainty as to the extent of the development of the digestive tract or the presence of either the mouth or anus.

At 11 P. M., on the 8th, or two days and three hours after fertilization, I found one embryo that so exactly resembled figure 36, that it might have been the original from which the figure was drawn. About this time I experienced my first difficulty in finding specimens, but my observation of those embryos discovered was very careful and close, and I have no doubt that their development so far was similar to that of our own species. Subsequent to this time, the intervals between my observations were greater, owing to the necessity of my employment upon other duty; and my absence from the vessel compelled me to put the embryos under the care of others; consequently in the intervening hours, changes may have occurred which are unknown to me, and many of the embryos may have advanced beyond the latest stages which came under my observation, but so far as I know, none advanced beyond those stages figured by Brooks.

At 3.00 P. M., on the 9th, or two days and nineteen hours after fertilization, owing to the increased amount of water in the jar (I had by this time obtained a large one,) and to the mortality among the embryos, I found it very difficult to find any, and this difficulty was a constantly increasing one thence forward. Those specimens obtained had well developed shells, and the digestive tract could be readily distinguished, as could the cilia. The movements of the embryo were so rapid and erratic that I found great difficulty in keeping them under the high power for a sufficient time to decide as to the stage they had reached, but those least advanced appeared as figured by Brooks, in No. 38, while the older embryos presented the characteristics of figs. 39 and 42.

At 11 P. M., on the 10th, or four days and three hours after fertilization, the digestive tract and shells were readily distinguished, especially the latter, which were very apparent. The anus was observed in several cases and the course of the intestine from it to the stomach easily traced. The cilia of the velum was also apparent, even with the low power. The main features at this time were similar to those of figs. 42 and 44.

At 11.00 P. M., on the 12th, or six days and three hours after fertilization, the embryo had apparently undergone little or no change, except that a much larger number had reached the stage shown in figure 44. In all, the shells and digestive organs were well developed and apparent, and the movement of the cilia of the velum regular and rapid, though the cilia appeared to have decreased in size.

At 11.00 P. M., on the 13th, seven days and three hours after fertilization, there was no apparent change in those embryos that could be found. They appeared quite healthy and were rapid in their movements. The difficulty of obtaining specimens, however, had much increased.

At 11.00 P. M., on the 14th, eight days and three hours

after fertilization. I could only find a very few embryos after a long, patient and careful search, which occupied several hours. Those discovered were similar in all respects to those last described, and as figured by Brooks, in No. 44.

On the 15th, I met with a total failure in my search for the embryos, and it was both long and carefully conducted, and the same want of success attended me on the 16th, when I gave up the attempt to further trace the development.

It will be observed that I could not find any embryos of a more advanced stage than those figured by Brooks, and that owing, probably, to the irregular rate of segmentation, I found them at the latter stages at periods varying from three to eight days.

It is not probable that the disappearance of the embryo was due to a deficient supply of water, for during the latter days of their existence they were far more liberally supplied than before. Neither is it probably due to change of temperature, for, as will be seen by the following tables of maximum and minimum temperatures, the range of temperature was about the same throughout the eight days :

Date.	*Max. Temp.*	*Min. Temp.*	*Diff.*
6	71°	70°	1°
7	71°	64°	7°
8	73°	64°	9°
9	79°	60°	9°
10	75°	62°	13°
11	74°	60°	14°
12	71°	61°	10°
13	77°	64°	13°
14	75°	66°	9°
15	72°	64°	8°

The water supplied to the embryos was always allowed to stand a sufficient time to acquire the temperature of the air before being added to that already in the jar.

It is a coincidence at least worthy of notice, that with both species the embryos have disappeared at about the same stage of development.

All published accounts of the development of the European oyster agree in asserting or assuming that the impregnation of the ova occurs while they are either within the ovaries or shell of the parent, and that consequently artificial fertilization is impossible; this supposition my experiment effectually disproves. Again, should the artificial fertilization of the eggs and subsequent care of the embryo of the American species reach such a state of perfection as to make the process an addition to oyster culture, and one of practical importance, the agreement of the European species with our own in the early stages of development, will indicate a method by which the supply of oysters may be increased in localities whose need is even now far greater than our own.

In conclusion, I must express my indebtedness to the paper of Dr. Brooks upon the development of the American oyster, to which I have alluded, and without which I should have been somewhat at a loss for a means of registering the various changes which I witnessed in the development of the European oyster.

Respectfully, FRANCIS WINSLOW,

Master U. S. Navy.

U. S. Ship "Saratoga," at Sea, July 5th, 1880.

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NOTES

ON SOME OF THE

EARLY STAGES

OF

DEVELOPMENT OF THE CLAM,

OR MANANOSE.

(*Mya arenaria Linn.*)

BY

JOHN A. RYDER.

NOTES ON SOME OF THE EARLY STAGES OF DEVELOPMENT OF THE CLAM OR MANANOSE (Mya arenaria.)

The spawning period of this mollusk lasts from the 10th of September to about the middle of October, or for about forty days. The sex of the adults, in a spawning condition, may be very easily learned. Open the shell of the animal carefully, remove a small portion of the richly colored yellow body mass with a knife, scissors or forceps. These fragments, squeezed or "teased out" in a watch-glass with a few drops of sea-water, allow a milky fluid to escape. Under a magnifying power of four or five times, the eggs of the female are visible in this milky fluid as very minute white points of nearly uniform size. The male cells are too small to be seen with the aid of so low a magnifying power, and the fluid retains its milky appearance just as it does to the naked eye. It is only under high powers, as much as 250 diameters, with the compound microscope, that the spermatozoa or male cells may be made visible, as minute oval bodies with a long, lash-like tail in rapid motion. These differences enable the operator to distinguish the sexes, after a little experience; indeed, it is possible with training, to note the differences between the male fluid and the eggs of the female when removed from the animals, with the naked eye.

Artificial impregnation of the eggs was effected in the same way as in the case of the oyster; that is, portions of the ripe ovary of the female are removed and chopped up in a watch-glass or small saucer with sea-water, taking care to remove all the large fragments of ovarian tissue by straining the milky substance through bolting cloth,

which will allow little else than the eggs to pass through its meshes. The spermaries of the ripe males are treated in the same way in another saucer, after which the male cells mixed with sea-water may be poured into the dish containing the eggs. In two or three hours after the water containing the male cells has been poured over the eggs, development will have begun. The water should now be removed from time to time by pouring it out of the dish or tumbler, taking care not to stir up the eggs which have settled to the bottom. Soon, however, the embryos will begin to swim, when it will be necessary to remove the water in another way, or with the siphon.

The changes which occur in the eggs during development, succeed each other with considerable rapidity, and, as in the development of the oyster, there are very well-marked periods of active change of form, which alternate with periods of repose, while there is a bilateral symmetry which is just as well marked as in the latter and *Unio*. A power of 250 diameters enlarges the eggs satisfactorily; shows the freshly impregnated eggs as spheres measuring $\frac{1}{2}$ inch in apparent diameter, a proof that the actual diameter of the eggs is very nearly 1-500th of an inch. The eggs are not spherical when first removed from the ovary, but are usually irregular in form with a more or less well pronounced conical extremity, by which they were attached to the walls of the ovarian follicles. The other end is more or less irregularly rounded. A nucleus is plainly visible during this irregular stage, but no well defined egg-membrane is apparent.

The early stages which I was enabled to figure may not entirely cover the different phases through which the embryos pass at that time, but in view of the circumstance that there is but little known of the development of Lamellibranchiate or bivalve mollusks, and that little relates to but few forms, I feel justified in offering the results obtained from a study of the embryonic development of the Clam, which has not been studied hitherto. Though

I did not succeed in following the development farther than to the formation of a gastrula, and was not able to time the changes which were observed, owing to the fact that my watch was broken. I still hope to be able to make a series of observations which will include the later stages.

Figure 1.

Fig. 1 shows an egg which has been removed for some time from the ovary; the vitellus composed of minute corpuscles or spherules has assumed a rounded form, a nucleus is still visible as well as a clear nucleolus within it; the vitelline membrane has become defined, while the delicate thin membrane which held the eggs fast to the wall of the ovarian follicle remains attached as a transparent structureless film. It is the supposition, based upon the conclusions of other observers, that at this stage impregnation has not yet been effected. This is effected by the entrance of a single spermatozoan or male cell into the egg through the vitelline membrane, but as I have not noted a micropyle, either in the eggs of this animal or that of the oyster, it is very probable that the male cell finds its way into the vitellus through an opening in the vitelline membrane extemporized for its passage. We are, at any rate, not yet ready for a general conclusion as to the presence or absence of a micropyle in the Lamellibranchiate ovum, to which Balfour in his *Comparative Embryology*, Vol. I., p. 31, commits himself. The histology of the ovaries of more forms must be studied before we can decide, and no more promising field is open before us than the investigation of the ovogenesis of the oyster and clam, both of which are still unstudied in relation to this point.

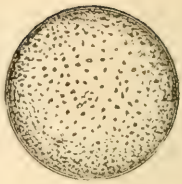

Figure 2.

Fig. 2 represents an egg of the clam after the lapse of perhaps two hours from the time it was first brought into contact with the male cell; it has apparently been impregnated, for the nucleus and nucleolus are no longer visible. It has also become perfectly spherical and has lost the membranous, filmy appendage of Fig. 1.

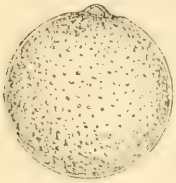

Figure 3.

Fig. 3 exhibits the same egg still later when the first polar cell has appeared as a minute blister-like prominence at one side. The polar cell is almost transparent and is situated in a slight depression, from which impressed lines radiate, making it appear as if the vitelline membrane were wrinkled in a radial manner. A similar radial wrinkling around the polar area is described by Whitman as occurring during the formation of the polar cells of the egg of a small fresh-water leech (*Clepsine*), but it is more strongly marked than in the egg of the clam. I have not noted this radial wrinkling in the egg of the oyster. After a while the egg represented in Fig. 3 undergoes farther change, a series of annular waves pass from the pole of the egg opposite the polar cell and a second polar cell is pushed out, when the radial wrinkles disappear and the polar cells present the appearance of two small spheres joined to each other and attached to the egg by a stalk as in Fig. 5. I should have stated before that the first polar cell originates in the same way as the second—by the passage of a series of waves from one pole to the other. These are not all of the forces that are at work in the extrusion of the polar cell: the nucleus of the egg has been undergoing changes of form, elongating and contracting, disappearing to assume a spindle form, then contracts into a rounded form, but with one end in intimate relation with the polar cells. These changes of

form seem to constantly accompany the expression of all the phenomena of active change in living cells, such as growth and division. Networks have been described in nuclei; the latter are known to expand and contract; elongate in the direction of certain lines of force; again withdraw into a globular form, so that Flemming has proposed the terms diastole and systole for these wonderful phenomena, which suggest, if they do not prove, the existence of forces of repulsion and attraction in active labor in the heart of every living cell. We have these phenomena presenting themselves to our vision in the eggs of the oyster and clam. The protoplasm of the egg tremulous with an intense life pent up and energetically trying to unfold itself soon causes the vitelline membrane to quiver and work in rolling waves and the egg assumes very rapidly the form shown in Fig. 4 as seen from below, and Fig. 5 as seen from the side. The two centres of force or nuclei are here indicated as two small clear spheres near the central part of the two cells which have been defined by a period of activity just past. The forces of growth now remain quiescent for a space, to be exhibited in one of their supremest moments of activity in Fig. 6, in which a portion of the largest cell or megamere is being separted to form a smaller cell or micromere. At the same time what was the small cell or micromere in Fig. 5 is as energetically dividing into two smaller cells or micromeres. The result is three micromeres. Looking more closely at the figure we see what appear to be lines of force running from the faintly marked nuclei of each of two cells to that of two others. The nucleus of the large cell is in vital relation with that which is budding from

Figure 4.

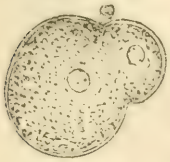

Figure 5.

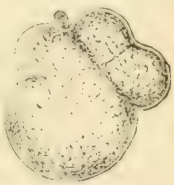

Figure 6.

it. So too, are the two small ones originating from the smaller cell of the stage shown in Fig 5. The notch which is moving inwards to nip off the small cell from the large one moves so fast that I find the camera lucida of use only so far as it enables me to get the dimensions. In like manner the contour lines on the other side are rapidly changing in the division of the smaller cell.

Figure 7.

Then follows a condition of rest shown in Fig. 7. The micromeres are now three in number, the megamere is still much greater in bulk than all three. The nuclei again become defined. The egg is passing slowly into the stage shown in Fig. 8, at the one pole of which we still see the polar cells persisting. The three micromeres have subsided; become depressed and the whole outline is more rounded, like that of the unsegmented egg. The faint indication of a segmentation cavity or space shown between the micromeres and megamere in Fig. 7, has disappeared. The embryo is quiescent and has reached the limit of perhaps its third or fourth period of activity and rest. The succeeding stage represented in Fig. 9 is where the next period of activity has reached its completion. The micromeres of Figs. 7 and 8 have again divided and one or two micromeres have been derived from the megamere; in this way a number of additional micromeres has been the result. The micromeres are now piled up at one side, or rather end, of the egg, and the polar cells still persist. The micromeres display a certain symmetry of arrangement. It now becomes apparent that the micromeres are to be the foundation of the epiblast or skin layer of the embryo, while the micromere is to become the hypoblast or inner layer from

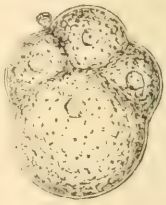

Figure 8.

Figure 9.

which the stomach and intestine is to be developed. In Fig. 9 the micromeres are slowly creeping down over the megamere which is finally enclosed by the former growing in a single layer from above downwards. This mode of developing a two layered stage of the embryo is known as epiboly, meaning that the epiblast grows over and upon the hypoblast which is here represented by the megamere. The megamere is finally pushed inwards and covered by the micromeres or cells of the epiblast. Once fairly inside and included by the epiblast as shown in Fig. 10, the megamere begins to divide as shown by the darkly shaded cells in the lower part of the figure. A depression appears in the middle of this cluster of cells which must, on anatomical grounds, be considered the orifice of invagination of the hypoblast. This orifice or blastopore may be considered the mouth of the so-called gastrula or stomach-stage of development, but it is never used as an inlet for food, which is not yet usable by the larva. The depression however persists, and there is every reason to believe that, like in the oyster and fresh-water mussel, it is the point where the shell-gland of the embryo develops and that it therefore marks the position of the back of the animal. Fig. 10 also illustrates plainly the position of the outside skin layer or epiblast *Ep.*, from which the mantle, gills, and siphons of the adult are derived, and its relation to the darkly shaded hypoblast cells *Hy.* inside, which finally become fully covered by the epiblast so as to appear like a cluster of cells in the inside of the hollow sphere formed by the latter. The central cluster may now be looked upon as the archenteron or primitive foundation from which a true stomach is derived.

Figure 10.

The way in which the gastrula stage of the clam is formed is so far unquestionably the same as that of the oyster; what lies beyond we cannot say, but it is in the highest degree probable that the history of its later stages

is much like that of the latter. Since we have been led along so far it will perhaps be profitable to inquire into the next phase of the oyster as throwing light upon the origination of the permanent mouth, stomach and intestines. Fig. 11, which I have copied from Salesnky, represents the larva of the European oyster at a stage considerably farther advanced than my Fig. 10 of the clam. I have inverted the original and changed the lettering somewhat, in order to make the figure correspond in position and to make the names of the parts agree with the nomenclature which I use.

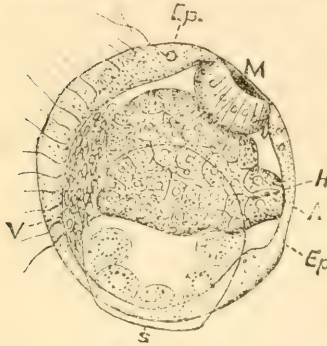

Figure 11.

The depression at *Hy.* in Fig. 10, has disappeared in Fig. 11 and the shell *S* covers the spot. It will be noticed too, that the hypoblast *Hy.* has arranged itself anew and has been broken up into smaller cells and is completely covered by the epiblast *Ep.* The Hypoblast is also beginning to show signs of becoming hollow in the center, and a true archenteron has probably been defined, but as yet there is no communication with the outside. It will also be noticed that the hypoblast, as a whole, has been pushed farther up relatively than in Fig. 10, and that it is in close contact with the epiblast at *M* and *A*. Sin-Singularly enough, the first evidence of a mouth appears as a depression in the epiblast at a point nearly opposite *S*; the depression *M* slowly deepens and finally breaks through, and is brought into communication with the archenteric cavity when not long after the vent breaks through at *A*, when the larval stomach and intestine are complete. By this time the velum *V* is developed, enabling the embryo to swim about by means of the rapid

lashing movement of the long lash like filaments arranged in a circle between the shell and the mouth.

In a general way, the segmentation of the egg of the clam appears to resemble, in its early stages, at least, the same process in *Anodonta*, as described by Flemming.* The conclusion that the clam is exactly parallel to Anodonta in its development is not, however, warranted for this reason, and to clear up the questions raised here, we must await the results of another season's work.

*Studien in der Entwickelungsgeschichte der Najaden. Sitzb. de k. Akad. der Wissensch., LXXI. Bd., I and II Hft., p. 81. Vienna, 1875.

APPENDIX B.

OYSTER

AND

FISH LAWS.

OYSTERS.

PUBLIC GENERAL LAWS.

Chapter 198, *Laws of* 1880, *repeals Chapter* 181, *Laws* 1874, (*Sections* 3 *and* 5 *of which were repealed and re-enacted by Chapter* 380, *Laws* 1876,) *and enacts the following in lieu thereof, to be Article* 71, *Code of Public General Laws, title* "*Oysters.*"

SECTION 2. *Be it enacted*, That no steamer shall be used or employed in catching oysters in the waters of this State, with scoop, dredge or similar instrument, and no other boat shall be used in catching oysters with scoop, dredge or similar instrument, without first having been licensed as hereinafter provided.

Must obtain license.

SEC. 3. *And be it enacted*, That the Comptroller of the Treasury shall, upon application of any person who has been a resident of this State for twelve consecutive months next preceding such application, and to no other person, issue a license to such resident to employ such boat in catching oysters with scoop, dredge or similar instrument, within the waters of Chesapeake Bay and in Eastern Bay, outside of a line drawn from the southwest corner of Second Kent Point to Wade's Point; provided, that nothing herein contained shall authorize the catching of oysters with scoop, dredge or similar instrument, on any oyster bar within one and a half miles of Tolley's Point, Sandy Point, Hackett's Point, Thomas' Point, Holland Island Bar, Three Sisters, Swan Point Bar, Poplar Island, one-quarter of a mile west of, and between the island and the main land, nor within a half mile of Plum Point, and to buy and sell oysters in this State, which license shall hold

Who to receive license.

Prohibition specified.

good for one year, but shall only authorize the catching of oysters between the fifteenth day of October and the first day of April, but it shall be lawful for the owner of any such boat licensed, whenever said owner shall sell and convey by bill of sale for a bona fide consideration, said boat, unto any person who has been a resident of the State of Maryland for at least one year, to transfer the said license to said vendee with said boat, which license, when transferred, shall entitle said vendee with said boat to the same privileges for catching oysters in the waters of this State, that the original vendor or assignor had before said assignment; provided, the said vendee and assignee shall appear before the Comptroller of the Treasury and make oath before him to all the facts, matters, things and prerequisites required of said original vendor or assignor before taking out such licenses, upon which said license the said Comptroller shall certify the fact of said vendee or assignee have taken said oath, and for which said assignee or vendee shall pay the sum of five dollars, to be paid to the State of Maryland.

Right to transfer license.

Make oath of facts.

SEC. 4. *And be it enacted*, That the owner of such boat shall make oath before the Comptroller or his clerk, or if the owner be a resident of Baltimore city, he shall make oath before the Clerk of the Court of Common Pleas, or if a resident of a county, shall make oath before the Clerk of the Circuit Court of said county, that he is the bona fide owner of such boat to be described in the license; that he has been resident of the State for the time before mentioned; that there is no lien on said boat by a non-resident; that the said boat is not held with an intention to violate the provisions of this law, such applicant shall produce before the Comptroller, at the time of such application, the certificate of the taking of such oath, the Custom-House enrollment or license of such boat; and if such boat is under Custom-House tonnage, the owner shall swear as to her ton-

Must be bona fide owner.

nage ; the master of such boat shall make oath before the Comptroller or his clerk ; or if a resident of Baltimore city, before the clerk of the Court of Common Pleas, or the clerk of the county whereof he may reside, that he has been a resident of the State of Maryland for twelve months next preceding the time of taking such oath. Swear to tonnage.

SEC. 5. *And be it enacted*, That before granting such license, the Comptroller shall receive for it from the applicant, at the rate of three dollars per ton for every ton the boat may measure ; the license shall be exhibited whenever called for by any officer of the State of Maryland. License to be exhibited.

SEC. 6. *And be it enacted*, That any person who shall violate any of the provisions of the preceding sections shall be deemed guilty of a misdemeanor, and upon indictment and conviction in any Circuit Court, or before any Justice of the Peace of this State, before whom such case is tried, shall be fined not less than fifty dollars nor more than two hundred dollars, or sentenced to the House of Correction for a term not less than three months nor more than three years ; and the boat or vessel used in said violation, together with the papers, furniture and tackle on board of said boat or vessel at the time of the said violation, shall pay a penalty of not less than fifty dollars nor more than three hundred dollars for each and every violation of the preceding section. Penalty for violation.

SEC. 7. *And be it enacted*, That upon information given under oath to any Judge of the Circuit Court or Justice of the Peace, of any violation of any of the provisions of this act, he shall issue his warrant to the sheriff or any constable, requiring any of them to whom it may be directed, to summon a posse comitatus if necessary, and proceed forthwith to arrest the party or parties alleged to have been en- Issue warrant.

gaged in the violation of this act, and to seize and to take possession of any boat, canoe or vessel, together with all her tackle and apparel on board of the same, and deliver the same to the Judge of the Circuit Court or a Justice of the Peace of this State, to be dealt with according to the provisions of this act.

Penalty for resistance.

SEC. 8. *And be it enacted*, That any person or persons who shall resist any officer authorized under this act to make arrests, shall be deemed guilty of a misdemeanor, and upon indictment and conviction thereof in any court having jurisdiction, shall be imprisoned in the House of Correction for not less than three months nor more than three years, in the discretion of the court; the parties tried and acquitted under this act shall have the cost of such trial paid by the Comptroller of the State out of the funds created by this act.

Who to arrest.

SEC. 9. *And be it enacted*, That it shall be the duty of the sheriff, constable or officers of the State Fishery Force, to arrest any person or persons, and to seize any canoe, boat or vessel found violating any of the provisions of this act, and bring the offender or offenders before a Judge of the Court having criminal jurisdiction, or a Justice of the Peace most convenient or accessible, to be dealt with as herein provided.

Give immediate hearing.

SEC. 10. *And be it enacted*, That the Judge or Justice of the Peace, before whom any person or persons may be brought, charged under oath with violating any of the provisions of this act, the said Judge or Justice of the Peace shall either give the case an immediate hearing, or at the instance of the party or parties charged with a violation of this act, shall appoint some early day within the next ten days thereafter, to hear the case, the party or parties charged giving such good and sufficient bail as said Judge or Justice shall require, for his or their attendance, and on conviction of the offender or

offenders, the said Judge or Justice of the Peace shall impose a fine upon the offender or offenders of not less than fifty dollars nor more than two hundred dollars, or imprisonment in the House of Correction for not less than three months, nor more than three years, and the boat or vessel used in such violation, together with all the apparel and tackle on board, at the time of said violation, shall be held until said fine and costs are paid; provided, that if said fine shall not be paid within twenty days thereafter, it shall be the duty of the said Judge or Justice of the Peace to decree forfeiture of the said boat or vessel, together with all the apparel and tackle on board, and he is hereby authorized to order any sheriff or constable to sell said boat or vessel, together with all the apparel and tackle on board, to the highest bidder, for cash, after giving at least twenty days' notice of the time and place of said sale, and the proceeds of said sale shall go to the payment of the fine and costs of such prosecution, and the balance, if any, shall be paid to the owner of said boat or vessel; provided, the said owner shall have the right of an appeal to the Circuit Court.

Decree forfeiture.

SEC. 11. *And be it enacted*, That any boat owned wholly or in part by any non-resident, used in catching oysters in this State with scoop, dredge or similar instrument, shall be condemned by order of any Judge of the Circuit Court nearest the place of her capture, or if captured in Baltimore, by order of the Judge of the City Court, and shall be sold by the sheriff of the county where condemned, or if condemned in Baltimore city, by the sheriff of said city, to the highest bidder, for cash, after twenty days notice of the time and place of sale, such notice to be published at least three times in a newspaper having the largest circulation, printed in Baltimore city or in the county where condemned; one-fourth of the proceeds of such sale shall be paid to the party

To be sold to highest bidder.

making the capture, (except the officers of the State Fishery Force,) and the balance shall be paid into the Treasury of the State to be credited to the Oyster Fund.

Fines to be paid to clerk.

SEC. 12. *And be it enacted*, The fines accruing under this act shall be paid by the sheriff, constable or officers of the State Fishery Force, collecting the same, within ten days, to the clerk of the county or city where such fine may accrue, and such clerk shall account for the same in his next quarterly term to the Comptroller of the Treasury, to be placed to the credit of the Oyster Fund.

Penalty for violation.

SEC. 13. *And be it enacted*, That it shall be unlawful, without authority from the owner, for any person or persons to take or catch planted or bedded oysters; any person or persons violating the provisions of this section shall be deemed guilty of a misdemeanor, and on conviction in the Circuit Court of the county wherein the oysters were bedded, shall be fined not less than five dollars nor more than fifty dollars, or be sentenced to the House of Correction for a term not less than three months nor more than three years, at the discretion of the Judge or Justice trying the same.

When unlawful.

SEC. 14. *And be it enacted*, That it shall be unlawful for any person or persons to take or catch oysters, except for private use, to the amount of five bushels per day, or for sale of the same to any citizen or citizens of the neighborhood, and to them only for the purpose of being consumed where sold, or for the purpose of replanting or bedding in the waters of the counties wherein they are caught, or for sale to the citizens of the county wherein they are caught, and to them only for the purpose of replanting or bedding in the waters of said counties, between the fifteenth day of April and the first day of September, in each and every year; any person violating this section

Penalty for violation.

shall be deemed guilty of a misdemeanor, and fined by a Justice of the Peace of the county wherein the offence was committed, not less than fifty dollars, nor more than two hundred dollars, or imprisonment in the House of Correction for not less than three months nor more than three years.

SEC. 15. *And be it enacted*, That it shall be unlawful for any person or persons to take or catch oysters on Sunday or at night, or to carry oysters in the shell outside the State, between the first day of April and the first day of September; and any person or persons violating this section shall be fined a sum of not less than fifty dollars nor more than three hundred dollars, or sentenced to the House of Correction for a period of not less than three months nor more than three years, or forfeit the boat, vessel or canoe used in violation of this Act, at the discretion of the Judge or Justice of the Peace trying the same.

When unlawful.

SEC. 16. *And be it enacted*, That the Comptroller of the Treasury shall have painted in black figures on white canvas two sets of numbers, corresponding to the license to catch oysters with scoop, scrape, dredge or any similar instrument, each figure shall be twenty-two inches in length and of proportionate width, and the figures at least six inches apart, and he shall give to each person taking out such license two numbers thereof, one of which shall be firmly sewed upon the starboard side, and in the middle of that part of the mainsail which is above the close reef, and the other number on the port side, and in the middle part of the jib, which is above the bonnet and reef; these numbers shall be placed in an upright position, and worn at all times during the dredging season, and shall not be concealed or defaced, and no other number shall be exposed to view or used than that which is furnished by the Comptroller; any person or persons who shall violate

Numbers to correspond with license.

Numbers — where placed.

the provisions of this section, shall be deemed guilty of a misdemeanor, and upon conviction in any Circuit Court in this State, or before a Justice of the Peace, shall be fined not less than fifty dollars, nor more than one hundred dollars, or imprisoned in the House of Correction, for a period of not less than three months, nor more than two years: provided, the Court or Justice of the Peace trying the same, shall be convinced that the provisions of this section have been intentionally violated.

Must obtain license.

Boundaries to be strictly construed.

SEC. 17. *And be it enacted*, That any resident of this State, desiring to use any canoe or other boat, in catching or taking oysters with rakes or tongs for sale, in any of the waters of this State, shall first obtain, by application to the Clerk of the Circuit Court of the county wherein he may reside, a license therefor, and such license shall have effect from the first day of June, in the year in which they may have been obtained, to the first day of June next succeeding; provided, that such license shall not authorize the use of said canoe or boat in taking or catching oysters in any creek, cove, river, inlet, bay or sound within the limits of any county, other than that wherein the license shall have been granted, and that the boundaries of counties bordering on navigable waters, shall be strictly construed so as not to permit the residents of either county to take or catch oysters beyond the middle of the dividing channel; provided, that nothing in this section shall be so construed as to prevent the citizens of St. Mary's and Calvert counties from using the waters of the Patuxent river in common, or the citizens of Queen Anne's and Kent counties from using the waters of Chester river in common, or the citizens of Dorchester and Wicomico counties from using the waters of the Nanticoke river in common, or the citizens of Queen Anne's and Talbot counties from using the waters of Wye river and the mouth thereof in common, or citizens

of Dorchester or Talbot counties from using the waters of the Choptank river in common.

SEC. 18. *And be it enacted*, That each and every license to take or catch oysters for sale, with rakes or tongs, shall state the name and residence of the person to whom the same is to be granted, the number, together with the length to be obtained by top or over all, measurement of the canoe or boat licensed, the county in which the same is to be used and the period at which said license will expire, and every applicant for such license shall pay to the Clerk of the Court where such license may be granted, and before the issuing and delivery of the same, according to the following rates, viz: For any boat measuring in length twenty feet or less, the sum of two dollars; measuring from twenty to twenty-five feet, the sum of three dollars; measuring from twenty-five to thirty feet, the sum of four dollars; and all over thirty feet, including sloops under Custom House tonnage, the sum of five dollars each, and all oysters taken with rakes or tongs shall be culled upon the natural beds where they are taken: the amount received from tonging license to be paid by the Clerk to the School Commissioners, for the public schools in the respective counties where such license is issued; provided, the sum received from white tongers shall go to white schools, and the sum from colored tongers shall go to the colored schools.

State name and residence.

Rates to be charged.

SEC. 19. *And be it enacted*, That every applicant for license to use any canoe or other boat in taking or catching oysters with rakes or tongs, shall be required to make oath or affirmation before the clerk authorized to issue the same, or some Justice of the Peace, on whose certificate of the taking of such oath or affirmation the clerk shall issue said license: that the facts set forth in said license are strictly true; that he has been a bona fide resident of the county for the twelve months next

Make oath or affirmation.

preceding his application for said license; that he desires and intends to use said canoe or boat only in the county in which he resides, or in the waters used in common, as herein provided in this act; that he will not allow the same to be used for taking oysters by non-residents of the county; that he will comply with and obey all the laws of this State, regulating the taking or catching of oysters; and every person to whom such license shall have been granted, shall paint the number of his canoe or boat on the outside thereof, near the gunwale, in black figures, and not less than three inches in length, and of proportionate width, in a white ground, and no number, other than that in the said license, shall be exposed to view on said canoe or boat; and any person failing to comply with this provision before using said boat or canoe for the purpose aforesaid, shall, on conviction thereof before a Justice of the Peace, be fined not less than five dollars, nor more than ten dollars, and any person who may refuse to pay said fine, shall be committed to the county jail for the period of thirty days, or until said fine be paid.

Paint number of boat.

SEC. 20. *And be it enacted*, That the Comptroller of the Treasury shall cause to be printed and delivered to the Clerks of the Circuit Courts of the several counties, the requisite number of such blank licenses, and take receipts for the same, as for orther licenses furnished; and the said clerks shall, on the first Monday of March and December, in each year, return to the Comptroller a list and account of such licenses, issued by them, and no licenses to take or catch oysters with rakes or tongs shall be issued to any boat or vessel which is licensed to take or catch oysters with scoop, drag, dredge or any similar instrument.

Blank licenses to be furnished clerks.

SEC. 21. *And be it enacted*, That if any person shall use any canoe or boat, not licensed as required by the preceding section of this

article, in taking or catching oysters with rakes or tongs, except for private use, he shall, upon conviction thereof before a Justice of the Peace for the county wherein the offence has been committed, be fined not less than twenty nor more than one hundred dollars; and in case of refusal to pay the said fine, said party shall be confined in the House of Correction for a period not less than three months, nor more than three years.

Fine for violation.

SEC. 22. *And be it enacted*, That all moneys arising from fines, penalties or forfeitures imposed under this article, shall, upon warrant of the Comptroller, be paid into the Treasury and placed to the credit of the Oyster Fund; and the Comptroller is hereby required to state in his annual report, particularly, the receipts and expenditures on account of said fund, the balance standing to the credit of the State at the time of making such report.

Fines to be paid into treasury.

SEC. 23. *And be it enacted*, That the owner or owners of any land bordering on any of the navigable waters of this State, the lines of which extend into and are covered by said waters, shall have the exclusive privilege of using the same for protecting, sowing, bedding or depositing oysters or other shell fish, within the lines of their own land; and any owner or owners of land lying and bordering upon any of the waters of this State shall have power to locate and appropriate in any of the waters adjoining his, her, or their lands, five acres, for the purpose of protecting, preserving, depositing, bedding or sowing oysters or other shell fish; and that any other citizen of the State shall have power to locate and appropriate five acres in any waters in said State not located or appropriated; provided, thirty days notice in writing shall be given the owner or owners, occupant or occupants of land bordering on said water proposed to be located; that the owner or owners, occupant or occupants,

Have exclusive privilege.

Power to locate five acres.

may have priority of claim, and if they shall fail to locate or appropriate the water mentiontioned in said notice within thirty days after receiving the same, then it shall be open and free to any one under the provisions of this section ; provided, also, that the said location or appropriation shall be described by stakes, bushes or other proper and visible metes and bounds, which description shall be reduced to writing under the oath of some competent surveyor, and recorded at the expense of the party locating or appropriating the same in the office of the Clerk of the Circuit Court in the county wherein such land may be located ; and provided, also, that such location and appropriation shall not injure, obstruct or impede the free navigation of said waters ; and provided, that no natural bar or bed of oysters shall be so located or appropriated, and that six months peaceful possession of all locations of oyster grounds under the laws of this State shall constitute a good and sufficient title thereto ; but should any one, within the six months herein provided, be charged with locating or appropriating any natural bed or bar hereinbefore prohibited, the question may be at once submitted by any person interested, to the judge of the circuit court in the county where such questions shall arise, who, after having given notice to the parties interested, proceed to hear the testimony and decide the case, and if decision be in favor of the party locating said five acres, said decision shall be recorded with the original record of said five acres, and shall in all cases be conclusive evidence of title thereto.

Describe by stakes.

Hear testimony.

SEC. 24. *And be it enacted*, That if any creek, cove or inlet, not exceeding one hundred yards at low water in breadth at its mouth, make into the lands, or that if any creek, cove or inlet of greater width than one hundred yards at low water mark, make into the lands, the owner or owners, or other lawful occupant

or occupants, shall have the exclusive right to to use such creek, cove or inlet when the mouth of said creek, cove or inlet is one hundred yards or less in width, and when the said creek, cove or inlet is more than one hundred yards in width at its mouth at low water, the said owner or owners, or other lawful occupant or occupants, shall have exclusive right to use such creek, cove or inlet, so soon as said creek, cove or inlet in making into said land or lands, shall become one hundred yards in width at low water, for preserving, depositing, bedding or sowing oysters or other shell fish, although such cove, creek or inlet may not be included in the lines of any patent. Exclusive right.

SEC. 25. *And be it enacted*, That the Board of Public Works is empowered and directed, to purchase for each of the guard boats, such arms and ammunition as may be necessary to make them efficient. Purchase arms.

SEC. 26. *Be it enacted*, That for the more efficient working of the State Fishery Force, the waters of this State shall be divided into seven districts, of which the waters of Kent county and Queen Anne's, shall be the first; the waters of Queen Anne's and Talbot, shall be the second; the waters of Dorchester and Talbot, the third; the waters of Wicomico, the fourth; the waters of Somerset county, the fifth; the waters of Anne Arundel county, the sixth; the waters of St. Mary's, Charles and Calvert, the seventh; each of the said districts shall be guarded by one sailing vessel, except the third and seventh, which shall be guarded by two; and it shall be the duty of the deputy commander of the first district, to guard the waters of Chester river, belonging to Queen Anne's county and the waters of Kent county, including Swan Point Bar; and the duty of the commander of the second district, to guard the watrs of Eastern Bay and its tributaries, and the waters of Talbot county, as far down as Black Divide into districts. How guarded.

Walnut Point; and it shall be the duty of one of the deputy commanders of the third district, to guard the waters of Choptank river and its tributaries, which lay in Talbot county; and the duty of the commander of Wicomico county boat, to guard the waters of Wicomico county, and the line between Somerset and Wicomico county; and the remaining commanders to guard their respective districts; provided, that the Board of Public Works or the commander of the Fishery Force, are hereby authorized and empowered to order the deputy commanders to do duty in any of the waters in this State when, in the judgment of either, they may deem it necessary.

Perform duties in other waters.

Power to appoint.

SEC. 27. *And be it enacted*, That the Board of Public Works shall have power to appoint a suitable person to command said force, to appoint the deputy commanders for their respective districts from persons of the counties whose waters comprise the different districts, who shall be commissioned by the Governor, and the said commander and deputy commanders shall have power to appoint their subordinates, and select their crews; and the term of office of said commander and deputy commanders shall be for two years, unless sooner removed for incompetency or neglect of duty, and if any of said officers shall fail in the discharge of his duty by reason of collusion with parties interested in violating any of the provisions of this act, he shall be guilty of a misdemeanor, and on indictment and conviction in a court of law, shall be fined or imprisoned at the discretion of the court.

Power to remove.

SEC. 28. *And be it enacted*, That the Board of Public Works shall have the power to remove any officer of said force for neglect of duty or incompetency, and any officer commanding in said force, shall have the power to remove any subordinate under his command, and appoint a person to fill the vacancy whenever the inter-

est of said service may, in his judgment, require him to do so.

SEC. 29. *And be it enacted*, That the Board of Public Works shall have power to keep the steamer and said vessels in good order, and the Treasurer of the State, upon requisition of the said Board, and the warrant of the Comptroller, is hereby required and directed to pay the sum or sums necessary to carry out the provisions of this act. To pay sums necessary.

SEC. 30. *And be it enacted*, That the commanding officer who shall have charge of the steamer, may be selected from the State at large, but the deputy commanders shall be selected from the districts in which they are to serve. How selected.

SEC. 31. *And be it enacted*, That the commanding officer be, and he is hereby, required to keep his vessel constantly on duty when circumstances will permit; and that every locality where a violation of the law is likely to occur, shall be visited as often as the duties of the force and condition of the vessel will allow, and that every three months a report shall be made to the Board of Public Works of all official action taken under the law, and of all money received for license issued to parties engaged in carrying oysters taken in this State, which on warrant of the Comptroller shall be paid into the Treasury. Keep on constant duty.

SEC. 32. *And be it enacted*, That it shall be the duty of the deputy commanders to confine themselves ordinarily to their several districts; but it shall also be their duty to enforce any of the provisions of this act in any waters adjacent to their districts, when a violation of the same shall come to their knowledge, and that they shall report quarterly to the Comptroller the amount of moneys received for licenses issued to persons engaged in carrying oysters, taken in this State, and on receiving his warrant shall pay the same into the Treasury. Confine to districts.

Take oath.

Enter into bond.

SEC. 33. *And be it enacted*, That the commanding officer and the deputy commanders of said force, shall, before entering upon the discharge of their duties, take, before one of the Judges of the Circuit Court, the oath prescribed by the Constitution, and the commanding officer of said force shall enter into bond to the State of Maryland in the sum of ten thousand dollars, and each deputy commander in the sum of three thousand dollars, to be approved by said judges, for the faithful performance of their duties as prescribed in this act; the said bond or bonds to be filed with the Comptroller.

Salary of commander.

Salary of appointees.

SEC. 34. *And be it enacted*, That the salary of the commanding officer in charge of steamer shall be one thousand five hundred dollars per annum, and he shall have power to appoint one officer, at a salary of seven hundred dollars per annum; one engineer at eight hundred dollars per annum, and one officer at six hundred dollars per annum, two seamen at twenty-five dollars per month; two seamen at twenty dollars per month; one fireman at thirty dollars per month; one fireman at twenty dollars per month; one steward at twenty dollars per month, and one cook at twenty-five dollars per month; and each deputy commander shall receive a salary of eight hundred dollars per annum; he shall have power to appoint one officer at a salary of five hundred and fifty dollars per annum, and three seamen at a salary of thirty dollars per month each, to be selected from the districts in which they are to serve.

Rations.

SEC. 35. *And be it enacted*, That the officers and crew of the steamer aforesaid, shall each receive one ration per day, of the quality and quantity, such as is allowed by law to the officers and crew of the Revenue Marine of the United States, but no rations shall be allowed to officers or crews of the sailing vessels.

SEC. 36. *And be it enacted*, That the officers

and crews aforesaid, shall be paid monthly by the Treasurer, upon warrant of the Comptroller and the certificate of the commanding officers, that their duties have been performed, as required by law. Monthly payments.

SEC. 37. *And be it enacted*, That all oysters in the shell disposed of in the State of Maryland, shall be measured in a sealed measure of any capacity, from half a bushel to three bushels, that may be agreed upon between the seller and purchaser; provided, that the said measure or measures shall contain in quantity for each bushel thereof, according to the following dimensions: That is to say, sixteen and a half inches across, from inside to inside at the bottom, eighteen inches across from inside to inside at the top, and twenty-one inches diagonal from the inside chime to the top, and the same shall be even or struck measure. How measured. Dimensions of measure.

SEC. 38. *And be it enacted*, That it shall be the duty of the purchaser or seller to have and use said measure or measures, duly inspected and sealed by the proper officers, and that no other measure shall be used under a forfeit of fifty dollars for each and every offence, to be recovered before any Justice of the Peace, by action of debt, in the name of the State of Maryland, one-half to go to the informer, the other half to be paid to the Comptroller, to be placed to the credit of the oyster fund. Inspect and seal measure.

SEC. 39. *And be it enacted*, That if any boat or vessel shall be seen sailing over any of the waters of this State, which are exempted from dredging by law, in the same manner in which they sail to take or catch oysters with scoop, scrape, drag, dredge or similar instrument, the said boat or vessel shall be pursued by any officer or officers authorized by this act to make arrests, and if said boat or vessel apprehended by said officer, shall be found to have on board any wet oysters on deck and properly equipped Officers to pursue.

for taking or catching oysters with scoop, scrape, drag or dredge or similar instrument, it shall be prima facie evidence that the said boat or vessel has been used in violation of this act, and it shall be the duty of the officer to arrest the person in command of said boat or vessel, and seize the said boat or vessel, together with all her equipments, and bring the same before a Judge or Justice of the Peace most accessable, to be dealt with according to law; provided, that nothing in this act shall be construed to prohibit vessels from seeking harbor in any waters of this State.

Officere must arrest.

Where culled.

Fine for violation.

SEC. 40. *And be it enacted*, That all oysters taken from any of the waters of this State, shall be culled upon their natural bed or bar; any person or persons violating the provisions of this section, shall be deemed guilty of a misdemeanor, and upon trial and conviction before any Judge or Justice of the Peace of this State, shall be fined not less than fifty nor more than three hundred dollars, or sentenced to the House of Correction for a term not less than three months, nor more than three years, or forfeit the canoe or vessel used in said violation.

Right of appeal.

SEC. 41. *And be it enacted*, That any person or persons convicted under any of the provisions of this act, shall, in all cases, have the right of an appeal.

How construed.

SEC. 42. *And be it enacted*, That nothing in this act shall be construed so as to apply to Worcester county.

Arrest for violation.

SEC. 43. *And be it enacted*, That it shall be the duty of the commander of the steamer to diligently watch and guard and to arrest all persons dredging, tonging or scooping without license, and the commanders of the sailing vessels shall likewise guard and arrest all persons for any violation of the law in this respect in their several districts; any violation of duty

in this respect shall be deemed a sufficient cause of removal.

SEC. 44. *And be it enacted*, That nothing contained in this act shall be construed to effect any prosecutions for the violation of the existing law now pending in this State. How construed.

SEC. 45. *And be it enacted*, That this act shall take effect from the date of its passage. Effective.

PUBLIC LOCAL LAWS.

DORCHESTER COUNTY.

Capter 299, *Laws* 1880, *amends Chapter* 325, *Laws* 1878, *which repealed Chapter* 214, *Laws of* 1874, *by adding an additional section.*

Captains to arrest.

SECTION 13. *And be it enacted*, That the captains of every licensed canoe, boat or vessel under this act, shall be a police officer for making special arrests, and the School Commissioners of Dorchester county are hereby authorized to allow any such captain one-half the fine that is paid to the said board for arrests made by him of non-residents taking or catching oysters in the waters of said county.

POTOMAC RIVER.

Chapter 36, *Laws* 1880, *regulates the catching of Oysters in the Waters of the Potomac River.*

Not to catch oysters without license.

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That no boat or vessel propelled by steam shall be used in catching oysters in the waters of the Potomac River, and no other boat shall be used in catching oysters with scoop, dredge, drag or similar implement, in the waters of said river, without first having been licensed as hereinafter provided.

SEC. 2. *And be it enacted*, That the Comptroller of the Treasury shall, upon the applica-

tion of any person who has been a resident-citizen of this State for twelve months next preceding such application, and who is the bona fide owner of the boat or vessel sought to be licensed, and to no other person, issue a license to use such boat or vessel in catching oysters with scoop, dredge, drag or similar implement within such of the waters of the Potomac River as are not prohibited by the provisions of this act, which license shall hold good for one year, but shall only authorize the catching of oysters between the fifteenth day of October and the first day of April; but it shall be lawful for the licensed owner of any such boat, whenever such owner shall sell and convey by bill of sale for a bona fide consideration said boat to any person who has been a resident of this State for the twelve consecutive months next preceding such sale, to transfer the said license to said vendee with said boat, which license, when so transferred, shall entitle said vendee with said boat to the same privileges for catching oysters in the waters of the Potomac River that the vendor had before such sale, provided that said vendee shall appear before the Comptroller of the Treasury and make oath before him to all the facts, matters, things and prerequisites required of said original vendor before taking out such license, upon which said license said Comptroller shall certify the fact of said vendee having taken said oath, and for which the said vendee shall pay the sum of five dollars, to be paid to the State of Maryland.

Issue license.

May transfer license.

Certify to fact of oath.

Sec. 3. *And be it enacted*, That the owner of such boat shall make oath before the Comptroller or his clerk that he is the bona fide owner of such boat to be described in the license: that he has been a resident-citizen of the State for the time beforementioned; that there is no lien on said boat held by a non-resident, and that said boat shall not be used in violating the provisions of this act; such applicant shall exhibit to the Comptroller at the time of such applica-

Not to violate the provisions of this act.

tion the Custom House enrollment or license of such boat, and if such boat is under Custom House tonnage shall swear to her tonnage.

SEC. 4. *And be it enacted*, That before granting such license the Comptroller shall receive for it from such applicant the sum of three dollars per ton for every ton the boat may measure; said license shall be exhibited whenever called for by any officer of the State Fishery force or any person having a right under the provision of this act to make arrests and seizures for violating any of its provisions.

License to be exhibited.

SEC. 5. *And be it enacted*, That no person or boat licensed under the provisions of this act shall take or catch, or be used in taking or catching oysters with scoop, dredge, drag or similar implement, in any waters of the Potomac River of less than twelve feet in depth, nor in any of the waters of said river between the Maryland shore and straight lines as follows: From the most eastern point of the headland known as Posey's Bluff, to a buoy near the southern or south-eastern point or prong of Herron Island Bar, thence to Blackistone's Island Light House, thence to a buoy near the end of Cobb Point Bar.

Depth of waters.

SEC. 6. *And be it enacted*, That if any person or persons having been licensed under this act to catch oysters with scoop, dredge, drag or similar implement, in the waters of the Potomac river, shall violate the provisions of the preceding sections, such person or persons shall be liable to arrest, and the boats, vessels and equipments used shall be seized, and upon proof of such violation before a Justice of the Peace or a Judge of the Circuit Court for the county nearest the place of such violation, on arrest and seizure shall be fined not less than fifty dollars nor more than three hundred dollars; and said fines and all costs of prosecution shall be a lien on the boats, vessels and equipments, which,

Liable to arrest.

if said fine and costs of prosecution be not paid within ten days after judgment, or appeal be not taken as hereinafter provided, shall be sold at public sale to the highest bidder for cash, under such orders and notice as the Judge or Justice aforesaid may prescribe; if said arrest and seizure be made by an officer of the State Fishery Force, said fine shall be paid into the Treasury of the State; but if made by any other person or persons having the right to arrest and seize, one-half of said fine shall be paid to the Clerk of the Circuit Court of the county in which the case has been tried, to be paid by said Clerk to the Comptroller of the State, and the other half shall be equally divided between the parties who made or assisted in making the arrest and seizure.

To be sold at public sale.

SEC. 7. *And be it enacted*, That any boat, vessels and equipments owned wholly or in part by any non-resident, used in catching oysters in the waters of the Potomac river with scoop, dredge, drag or similar implement, upon seizure and proof shall be condemned by any Judge of the Circuit Court or Justice of the Peace of the county nearest the place of her capture, and shall be sold by the Sheriff of the county where condemned, to the highest bidder for cash, after ten days' notice of the time and place of sale; one-half of the proceeds of sale, less half the costs of prosecution and sale, shall be paid to the parties who made the capture, except when the capture was made by the State Fishery Force, and the balance shall be paid into the Treasury of the State.

Shall be condemned.

SEC. 8. *And be it enacted*, That the Comptroller of the Treasury shall have painted in black figures, on white canvas, two sets of numbers corresponding to the license, to catch oysters with scoop, dredge, drag or similar implement; each figure shall be twenty-two inches long and of proportionate width, and the figures shall be at least six inches apart, and he shall give to each person taking out such

Printed numbers.

license two numbers thereof, one of which shall be firmly sewed upon the starboard side and in the middle of that side of the mainsail, which is above the close reef, and the other number on the port side and in the middle part of the jib, which is above the bonnet and reef. These numbers shall be placed in an upright position and be worn at all times during the dredging season, and shall not be concealed or defaced; and no other number shall be exposed to view or be used than that which is furnished by the Comptroller. Any captain or other person in charge who shall vilolate the provisions of this section shall, upon proof of such violation before a judge of the circuit court or justice of the peace of the county nearest which such violation occurred, be subject to a fine of not less than fifty dollars nor more than one hundred dollars, and such fine and the costs of prosecution shall be a lien upon such boat or vessel on which were violated the provisions of this section, and unless said fine and costs be paid within ten days or appeal be taken, such boat or vessel shall be sold at public sale to the higest bidder for cash, under such orders and notice as the judge or justice of the peace may prescribe; one-half of the fine to be paid to parties making the arrest and capture unless the arrest and capture be made by the State Fishery force, and the balance to the treasury of the State.

Subject to fine.

SEC. 9. *And be it enacted*, That any person who has been a resident-citizen for the twelve months next preceding his application of a county bordering on the Potomac River, desiring to use any canoe or other boat in catching oysters for sale, with rakes or tongs in any of the waters of the Potomac River, shall first obtain, by application to the clerk of the circuit court for the county wherein he resides, a license therefor, and such license shall have effect from the first day of June in the year in which it may have been issued to the first day

County license.

of June next succeeding; provided that such license shall not authorize the use of said canoe or boat in taking or catching oysters in any creek, cove, inlet, bay or sound within the limits of any county other than that wherein the license shall have been issued.

SEC. 10. *And be it enacted*, That each and every license to catch oysters, for sale, with tongs or rakes in the waters of the Potomac River, shall state the name and residence of the person to whom the same is granted, the number and length of the canoe or boat by top or over-all measurement, the county in which the same is to be used, and the period at which said license will expire; said license shall also state that the holder thereof is, by virtue of said license, authorized and required to make, or assist in making, arrest of any persons, and seize any boats, vessels and equipments engaged in violating the provisions of this act. For such license the applicant shall pay to the Clerk of the Circuit Court issuing the same as follows: For a boat or canoe measuring in length twenty feet or less the sum of two dollars; for a boat or canoe twenty to twenty-five feet in length the sum of three dollars; for a boat or canoe twenty-five to thirty feet in length the sum of four dollars; for a boat or canoe over thirty feet in length the sum of five dollars; and for sloops under Custom House measurement the sum of six dollars. And all oysters taken shall be culled upon the natural beds where they are taken. The amount received from tonging licenses shall be paid by the Clerk to the School Commissioners for the Public Schools of the respective counties where such licenses are issued, provided the sum received from white tongers shall be applied to the white school fund, and the sum from the colored tongers to the colored school fund. No license to tongers under the provisions of this act shall authorize the catching of oysters for sale during the months of April, May, June, July and August. And any person or persons violating the

State name and residence.

Amount to be paid.

provisions of this section shall be subject to like penalties as are prescribed by the preceding sections of this act.

Required to make oath.

SEC. 11. *And be it enacted*, That every applicant for license under this act, to use any canoe or other boat, in catching oysters for sale, with rakes or tongs, shall be required to make oath or affirmation, before the clerk authorized to issue the same, or some Justice of the Peace of the county, on whose certificate of the taking such oath or affirmation the clerk shall issue such license; said oath or affirmation shall assert that he has been a resident-citizen of the county for the twelve months next preceding his application, the length of the boat or canoe to be used; that he is the bona fide owner of said boat or canoe; that he will not violate the provisions of this act; that he will arrest and seize, or assist in arresting and seizing all persons and boats, vessels and equipments engaged in violating the provisions of this act, so far as it may in his power to do so, and that he will not employ or permit any person to use his boat or canoe so licensed, on hire or shares, who has not been a bona fide resident citizen of the county for the twelve months next preceding such employment or permission to use, and that he will inform against and prosecute all persons who shall violate this or any other provision of this act. The penalty for violating any of the provisions of this section shall be not less than ten dollars, nor more than fifty dollars, to be recovered before a Justice of the Peace of the county, and said fine and costs of prosecution shall be a lien upon the boat and equipments of the offending party, which, unless paid within ten days after judgment, shall be sold under orders and notice prescribed by the Justice of the Peace for the payment of such fine and costs, one-half of such fine to be paid to the County School Commissioners, and the other half to the informer.

Penalty for violation.

SEC. 12. *And be it enacted*, That every licensed tonger, under the provisions of this act, shall paint the number of his boat or canoe on the outside thereof, near the gunwale, on each side of the bow, in black figures of not less than four inches in length, and of proportionate width, in a white ground, and no number other than that in the license shall be exposed to view on said canoe or boat; and any person failing to comply with this provision, before using said boat or canoe for the purpose aforesaid, shall be subject to a fine of not less than five dollars, and not more than ten dollars, to be recovered and paid over as provided in section eleven of this act.

Paint number of boat.

SEC. 13. *And be it enacted*, That if any person shall use any boat or canoe not licensed, as provided by this act, in catching oysters with rakes or tongs, for sale, he shall be subject to a fine of not less than ten dollars and not more than fifty dollars, to be a lien on the boat or canoe of the offender, to be recovered and paid over as provided in section eleven of this act; and if said fine be not paid he shall be imprisoned in the county jail for not less than two nor more than six months.

Fine and lien on boat.

SEC. 14. *And be it enacted*, That the Comptroller shall cause to be printed and delivered to the Clerks of the Circuit Courts of the counties bordering on the Potomac River, the requisite number of such blank licenses as are required by the provisions of this act, and said Clerks shall, on the first Mondays of March and December in each year, return to the Comptroller a list and account of such licenses issued by them; and no license to catch oysters with rakes or tongs shall be issued to any boat or vessel which is licensed to take oysters with scoop, dredge, drag, or any similar implement.

Deliver blank licenses.

SEC. 15. *And be it enacted*, That it shall be unlawful for any person to catch oysters on Sunday or at night with scoop, dredge, drag or

Unlawful.

similar implement, or by tongs; any person violating this section shall be fined a sum of not less than fifty dollars nor more than one hundred dollars, the fine and cost of prosecution to be a lien on the boat, vessel and equipments used in violating the provisions of this section, and the case shall be tried and disposed of, and the fine and costs collected and paid over as provided in section six of this act.

Fine for violation.

SEC. 16. *And be it enacted*, That it shall be the duty of the officers of the State Fishery Force, the sheriffs, constables and licensed tongsmen of the counties bordering on the Potomac River, to arrest any person found violating the provisions of this act, and to seize all boats, vessels and equipments engaged or used in such violation, and to bring the offenders before a Judge of the Circuit Court or a Justice of the Peace, most convenient or accessible, to be dealt with as by this act provided, and to hold such boats, vessels and equipments to be disposed of to secure the payment of such fines and costs of prosecution adjudged as hereinbefore provided by the preceding sections of this act.

Arrest for violating.

Seize boats, vessels, &c.

SEC. 17. *And be it enacted*, That upon information given on oath to any Judge or Justice of the Peace of any violation of any of the provisions of this act, he shall issue his warrant for the arrest of the offender and the seizure of the boat, vessel and equipments, which warrant shall be directed to the sheriff, constable or any licensed tongsman of the county wherein such warrant is issued, or to any officer of the State Fishery Force, and said persons, when arrested, shall be carried before said Judge or Justice of the Peace, and the boat, vessel and equipments shall be held to be dealt with according to the provisions of preceding sections of this act.

Issue warrants for arrest.

SEC. 18. *And be it enacted*, That if any person or persons shall resist any officer author-

Resisting officer.

ized by this act to make arrests of persons and seizure of boats, vessels and equipments, he or they shall be deemed guilty of a misdemeanor, and upon indictment and conviction in any Court having criminal jurisdiction shall be fined not less than one hundred dollars nor more than five hundred dollars, or imprisoned in the House of Correction for not less than three months nor more than one year, or both fine and imprisonment in the discretion of the Court; and the fine and costs of prosecution shall be a lien on any boat, vessel and equipments that may have been seized when such offenders were arrested, and such boat, vessel and equipment shall be disposed of to secure the payment of such costs and fine as the Judge of the Court may direct, according to the provisions of preceding sections in this act.

Fine and imprisonment.

SEC. 19. *And be it enacted*, That for all oysters bought and sold on the Potomac river the following shall be the standard bushel measure, viz.: A solid iron tub, measuring sixteen and one-half inches across the bottom from inside to inside, eighteen inches across the top from inside to inside, and twenty-one inches from the inside bottom, diagonally, to the inside top. This measure, even full, shall be a bushel; and any person using a larger measure shall be subject to a fine of ten dollars for each and every offence against the provisions of this section, to be recovered by proceedings before a Justice of the Peace, one-half to be paid to the informer and the other half to the Comptroller of the State.

Standard bushel measure.

SEC. 20. *And be it enacted*, That any person or persons feeling aggrieved by the judgment of any Justice of the peace in any trial for a violation of any provision of this act, may appeal to the Circuit Court for the county in which such case may have been tried; provided he or they give notice of such appeal within ten days after judgment, and shall within ten days after judgment pay the costs that have

May appeal.

Appeal bond.

accrued, and deliver to said Justice of the Peace an appeal bond with two or more sureties, to be approved by said Justice of the Peace, executed to the State of Maryland, in the penalty of double the amount of fine or penalty adjudged by said Justice of the Peace, said bond to be conditioned for the successful prosecution of said appeal.

Money—how placed.

SEC. 21. *And be it enacted*, That all money paid into the Treasury of the State, under the provsions of this act, shall be placed to the credit of the "Oyster Fund."

Not to apply.

SEC. 22. *And be it enacted*, That the provisions of this act shall not apply to the citizens of the State of Virginia.

How effective.

SEC. 23. *And be it enacted*, That this act shall take effect upon the approval of this act, and the passage of a similar act by the State of Virginia.

SOMERSET COUNTY.

Chapter 40, *Laws* 1880, *protects Oysters in certain waters of Manokin River in Somerset County.*

Unlawful to catch oysters.

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That it shall not be lawful for any person or persons to employ any canoe, boat, or vessel in catching or taking oysters, with scoop, scrape, drag or dredge or any similar instrument, in the waters of the Manokin River in Somerset county, east of a straight line from Hazard Point on the south side of said river to South Point on the southeast end of little Deal's Island.

Fined for violation.

SEC. 2. *And be it enacted*, That any person or persons violating any of the provisions of this act shall be fined in a sum not less than one hundred dollars nor more than two hundred dollars for each and every offence, and shall stand committed to the county jail until such fine and costs shall be fully paid and satisfied.

SEC. 3. *And be it enacted*, That on information under oath of any violation of the provisions of this act to any Justice of the Peace of Somerset county, the said justice shall forthwith issue his warrant to the sheriff or any constable of said county, requiring the officer to whom the said writ shall be directed to summon a posse comitatus, if necessary, and proceed at once to arrest the party or parties alleged to have been engaged in violation of this act, and forthwith bring the offender or offenders before some Justice of the Peace of Somerset county for a hearing, and the said Justice of the Peace shall either give the case an immediate hearing, or at the instance of the party or parties charged with a violation of this act, shall appoint some early day within the next seven days thereafter to hear the case, the party or parties charged giving such good and sufficient bail as said Justice shall require for his or their appearance at the trial, and on the conviction of the offender or offenders the said Justice shall fine such person or persons in a sum not less than one hundred dollars nor more than two hundred dollars and costs, in each and every case, and shall have power and authority to commit to the jail of said county such offender or offenders so convicted until such fine or fines, so imposed, and costs, shall be fully paid and satisfied, subject to an appeal in all cases to the Circuit Court for Somerset county, from any judgment or conviction which may be rendered by said Justice of the Peace.

Issue warrant.

May commit to jail.

SEC. 4. *And be it enacted*, That all fines accruing from the enforcement of this act shall be paid by the said Justice of the Peace to the secretary and treasurer of the school board of Somerset county, for the use of the public schools of said county.

Fines for use of public schools.

SEC. 5. *And be it enacted*, That this act shall take effect on and after the first day of May next.

Effective.

Chapter 445, *Laws* 1880, *protects Oysters in the waters of Pocomoke Sound in Somerset County.*

Unlawful to take oysters.

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That it shall not be lawful for any person or persons to employ any canoe, boat or vessel in catching or taking oysters with scoop, scrape, drag or dredge, or any similar instrument, within the waters of Pocomoke sound, in Somerset county; nor shall any person or persons take or catch oysters for sale within said waters otherwise than with tongs, as restricted and regulated by the provisions of the General Oyster Law in force in this State.

Fine for violation.

SEC. 2. *And be it enacted*, That any person or persons violating the provisions of this act shall be fined in a sum not less than seventy-five dollars nor more than one hundred and fifty dollars for each and every offence, and shall stand committed to the county jail until such fine and the costs of suit are paid.

Issue warrant to sheriff.

SEC. 3. *And be it enacted*, That on information made under oath of any violation of the provisions of this act to any Justice of the Peace of Somerset county, he shall forthwith issue his warrant to the sheriff or any constable of said county, requiring said officer to proceed forthwith to arrest the party or parties alleged to have been engaged in the violation of this act, and bring him or them before said Justice at once for trial, and upon conviction shall be fined as required by section two of this act.

Give immediate hearing.

SEC. 4. *And be it enacted*, That the said Justice of the Peace shall either give the case an immediate hearing, or at the instance of the party or parties charged, shall appoint some early day, within the next five days thereafter, to hear the case, the party or parties charged giving such good and sufficient bail as said Justice shall require for his or their appearance;

and any party or parties feeling himself or themselves aggrieved by any conviction or judgment of said justice, shall have the right to appeal to the Circuit Court for Somerset county, which shall hear and determine the same as other cases on appeal.

SEC. 5. *And be it enacted*, That this act shall take effect upon the consent and ratification of the provisions of this act by the Legislature of the State of Virginia, as required by the compact between the States of Virginia and Maryland, in the year seventeen hundred and eighty-one. How effective.

WORCESTER COUNTY.

Chapter 214, *Laws* 1880, *repeals Sections* 2 *and* 4 *of Chapter* 277, *Laws of* 1876, *relating to Oysters in the waters comprised within the limits of Worcester County, and enacts following substitute therefor:*

SECTION 2. *And be it enacted*, That the clerk of the Circuit Court for Worcester county may issue to any citizen of said county a license to take or catch oysters with rakes or tongs, from the waters of Synepuxent bay and its tributaries, until the first day of May next after the issuing of said license; provided the applicant for said license shall satisfy said clerk by his own oath or other sufficient proof that he is a citizen of said county, and shall pay to said clerk the sum of one dollar, to be paid by said clerk to the County Commissioners of Worcester county, to be expended in the procuring of seed oysters to be planted in said bay as the commissioners aforesaid may direct; but no person licensed as above, nor any other person, shall take or remove any oysters from the waters of said bay or its tributaries on any Sunday or in the night at any season, nor during the day from the first day of May to the first day of September, or any shells from the natural rocks at any time; provided that nothing herein shall be construed to forbid any person May issue license. Satisfy by oath or proof. How construed.

from taking or catching his or her own planted oysters at any time and with any kind of instrument, and any person violating any of the provisions of this section shall be guilty of a misdemeanor, and upon indictment and conviction therefor, shall be fined not less than ten nor more than fifty dollars for each offence, with costs.

Plant and lay down oysters.

Marked by stakes, &c.

Fine for violation.

SEC. 4 *And be it enacted*, That it shall be lawful for any citizen of Worcester county to stake off, not exceeding five acres in any one place in the waters of Synepuxent bay and its tributaries, except upon the natural rocks of said bay and its tributaries, and to plant and lay down oysters in said waters so staked off; and that no person except the ower of said planted or laid down oysters, or his employee, shall work upon or among said oysters, or in the waters so staked off: provided that, that portion of the said waters in which oysters are, or are intended to be planted or laid down not exceeding five acres in any one place, be kept plainly marked by means of bushes, stakes or buoys; and any person wilfully or maliciously removing said bushes, stakes or buoys, shall be liable to all the penalties of this section; and provided further, that nothing in this section shall affect the rights of owners of land to the exclusive use of any creek, cove or inlet within their said lands, not exceeding one hundred yards in width at its mouth; and any person violating the provisions of this section, or any of them, shall be liable to be sued as for damages to any other property, and also to indictment by the grand jury of said county, and upon conviction for any such violation shall be fined not less than ten dollars nor more than one hundred dollars, with costs, or imprisoned not less than one month nor more than six months in the county jail, or both, at the discretion of the court, for each offence; and in any prosecution for violating any of the provisions of this section it shall not be necessary in order to convict, to prove that the offender was

actually taking up oysters, but only that he was at work in the waters so staked off by bushes, stakes or buoys as aforesaid.

SEC. 3 *And be it enacted*, That this act shall take effect from the date of its passage. Effective.

WICOMICO COUNTY.

Chapter 447, *Laws* 1880, *repeals Chapter* 241, *Laws* 1872, *protecting Oysters in the waters of Wicomico County and re-enacts the same with additional sections.*

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That it shall not be lawful for any person or persons to employ any canoe, boat or other vessel in catching or taking oysters with scoop, scrape, drag or dredge, or any similar instrument, within the waters of Wicomico county; nor shall any person or persons take or catch oysters within the waters of said county, otherwise than with tongs, as restricted and regulated by the provisions of the general oyster law in force in this State. Unlawful to take oysters.

SEC. 2. *And be it enacted*, That for the protection of young oysters in the waters of Wicomico county, it shall not be lawful for any person or persons to take or catch oysters above a straight line drawn from Sandy Island on the west side of the Nanticoke river, to Roaring Point on the east side of said river, between the first day of May and the first day of October, nor shall it be lawful for any person or persons, to convey beyond the limits of said county, any oysters from the first day of May to the first day of September in each and every year. Bounds and time for taking.

SEC. 3. *And be it enacted*, That any person or persons violating the provisions of either the first or second sections of this act shall be fined in a sum not less than twenty-five dollars nor more than two hundred dollars, or forfeit the canoe, boat or vessel in his or their possession, Penalty for violation.

together with the tackle and apparel, and all things on board at the time the offence may have been committed, and shall stand committed to jail until such fine shall be fully paid and satisfied.

SEC. 4. *And be it enacted*, That on information, under oath, of any violation of the provisions of this act, to any Justice of the Peace of Wicomico county, he shall forthwith issue his warrant to the sheriff, or any constable, or military officer, requiring either of them to whom it may be directed to summon a posse comitatus, if necessary, and proceed forthwith to arrest the party or parties alleged to have been engaged in the violation of this act, and to seize and take possession of any canoe or canoes, boat or boats, vessel or vessels, together with all their tackle and apparel, and all things on board of the same belonging to said party or parties, or in their possession at the time of the offence or offences and used by him or them in violating this act.

Issue warrant to sheriff.

SEC. 5. *And be it enacted*, That the sheriff, constable or military officer who shall make the arrest, shall forthwith bring the offender or offenders before some Justice of the Peace of Wicomico county, for a hearing, and the said Justice of the Peace shall either give the case an immediate hearing, or, at the instance of the party or parties charged with the violation of this act, shall appoint some early day, within the next five days thereafter, to hear the case, the party or parties charged with the violation or violations giving such good and sufficient bail as said Justice shall require for his or their attendance, and on conviction of the offender or offenders the said Justice shall fine such person or persons in a sum of not less than twenty-five dollars nor more than two hundred dollars in each and every offence, or shall decree a forfeiture of the canoe or canoes, boat or boats, vessel or vessels, together with all their tackle and apparel, and property found on board at

Give early hearing.

the time of the seizure, and shall have power and authority to commit to the jail of said county such offender or offenders so convicted, until such fine or fines so imposed shall be fully paid and satisfied. Power to commit.

SEC. 6. *And be it enacted*, That the Justice of the Peace before whom any such offender or offenders shall be tried and convicted, shall impose a fine of not less than twenty-five dollars nor more than two hundred dollars, or shall decree a forfeiture of the canoe or canoes, boat or boats, vessel or vessels used in such violation, together with all the apparel, tackle and property found on board, and he is hereby authorized to order any constable, sheriff or military officer, to sell the property so seized, on five days' notice, to the highest bidder for cash, subject to an appeal in all cases to the Circuit Court of Wicomico county; and after the payment of the expenses attending the arrest and prosecution in any such case, the officer making the arrest shall retain one-fourth of the balance himself, distribute one-fourth among the parties assisting in making the arrest and seizure, and pay over the remaining half to the State treasury, to be placed to the credit of the school fund for said county; provided if such seizure is made by the officers or crew of the Fishery Force of the State, then such portion as would accrue to them under the provisions of this act shall be paid into the treasury of the State and placed to the credit of the school fund for said county. Impose fine. Right of appeal.

SEC. 7. *And be it enacted*, That any person or persons on board of any canoe or canoes, boat or boats, vessel or vessels, engaged in violating any of the provisions of this act, and shall flee to avoid an arrest, the officer endeavoring to make such arrest shall seize such canoe or canoes, boat or boats, vessel or vessels used in such violation, and all property found on board, and the same proceeding thereupon shall be Seize canoe or boat.

had as in all cases of seizure under other sections of this act.

Duty of State Fishery force.

SEC. 8. *And be it enacted*, That upon information given, under oath, of any violation of this act, the commander and deputy commanders of the State Fishery Force of this State, it shall be the duty of the said commander or deputy commanders to arrest the offender or offenders, and seize the boat or boats, canoe or canoes, vessel or vessels, together with all their tackle, apparel and property found on board, and deliver them over to the authorities of the said county, to be dealt with according to the provisions of this act; and the said commander and deputy commanders are hereby authorized to follow such alleged offender or offenders, and make such arrest and seizure in any part of this State, as well as within the limits of said county.

Arrest with or without warrant.

SEC. 9. *And be it enacted*, That it shall be the duty of the commander and deputy commanders, with or without warrant, to arrest any person or persons, and to seize and to take into custody any canoe or canoes, boat or boats, vessel or vessels, with their apparel, tackle and property found on board of said boat, canoe or vessel, whenever such person or persons, canoe, boat or vessel shall be found violating, or being used in violating any of the provisions of this act, and bring the offender or offenders before a Justice of the Peace, to be dealt with as herein provided; and it shall be the duty of the Justice of the Peace before whom such person or persons shall have been taken by said officer, to take cognizance of the same and docket a case or cases in the name of the State against such person or persons, and the said boat, canoe or vessel; and the said justice shall proceed to try the same and render judgment as provided by this act.

SEC. 10. *Be it enacted*, That it shall not be lawful for any person or persons to take or catch oysters within the waters of Wicomico

county, except citizens of said county; and any person or persons violating the provisions of this section shall be subject to like penalties as are prescribed in the preceding sections of this act. Who are allowed.

SEC. 11. *Be it enacted*, That all owners and masters of canoes, boats or vessels licensed to take or catch oysters in the waters of Wicomico county, being white men, are hereby constituted officers for the purpose of arresting and taking before any Judge of any Circuit Court or Justice of the Peace who shall have jurisdiction therein, any person or persons who may be engaged in violating any of the provisions of this act, and of seizing any canoe, boat or vessel engaged therein; and all such owners and masters are hereby vested with power to summon the posse comitatus to aid in making such arrest and seizure. Constituted officers.

SEC. 12. *Be it enacted*, That if any canoe or canoes, boat or boats, vessel or vessels, shall be used by any person or persons within the limits of Wicomico county, in the same manner or way in which they are used to take oysters with scoop, scrape, drag, dredge, or similar instrument, it shall be the duty of any officer, created by this act, to pursue such canoe or canoes, boat or boats, vessel or vessels, and if the said canoe or canoes, boat or boats, vessel or vessels, shall be found to have on board any scrapes, cranks, dredges, or any similar instruments, or any other equipments necessary to take oysters with scoop, scrape, dredge, or similar instrument, it shall be the duty of the said officer to seize the said canoe or canoes, boat or boats, vessel or vessels, and to arrest the person or persons found on board and bring them before some Justice of the Peace in said county, to be dealt with according to the provisions of this act; and the necessary appurte nances being on board of said canoe or canoes, boat or boats, vessel or vessels, to take oysters with scoop, drag, dredge, or similar instrument, Duty of officer to pursue.

Evidence of violating.

shall be sufficient evidence that the said canoe or canoes, boat or boats, vessel or vessels, have been used in violating the provisions of this act.

Inconsistent acts repealed.

SEC. 13. *And be it enacted*, That chapter two hundred and forty-one, passed at the January session of the General Assembly, in the year eighteen hundred and seventy-two, entitled "An act to protect oysters within the waters of Wicomico county," and all other acts and parts of acts inconsistent with the provisions of this act be and the same are hereby repealed, and that this act shall take effect from the date of its passage.

Effective.

FISH AND FISHERIES.

PUBLIC GENERAL LAWS.

Chapter 260, *Laws* 1880, *repeals Chapter* 276, *Laws* 1878, *which repealed Chapter* 252, *Laws* 1876, *which repealed Chapter* 421, *Laws* 1874, *which repealed Section* 2, *Article* 41, *Public General Laws, title Fish and Fisheries, and re-enacts the same with substitutes and amendments, so as to read as follows:*

SECTION 1. No person shall from the tenth day of June to the first day of October in each year fish with hauling seine or drag-net of any kind within the Chesapeake Bay, or any of its tributaries lying northward of the following line, viz: Beginning at Still Pond, in Kent County, and drawn westward to Lego's Point, in Harford County.

Seine hauling prohibited.

SEC. 2. *And be it enacted*, That any person or persons violating any of the provisions of this act, upon conviction thereof before any Justice of the Peace of the county in which said act has been violated, shall pay a fine of fifty dollars, one-half of which shall go to the informer, and any hauling seine or hauling seines, drag-net or drag-nets, and the boat or boats and material used in fishing the same are hereby declared to be forfeited, and the Justice or Justices before whom said conviction and condemnation shall be had, is authorized and directed to have said fishing apparatus sold by the sheriff or constable making said arrest to the highest bidder, and the proceeds, together with half the fine, after deducting the cost, shall be paid to the County Commissioners of the county in which said offence shall be committed, for the use of the school fund of said county.

Penalty for violation.

Declared forfeited.

SEC. 3. *And be it enacted*, That any person or persons, on conviction, failing to pay the fine as prescribed in the preceding section, shall be imprisoned in the county jail of the county in which said offence shall be committed; provided, however, that any one so offending shall, upon conviction before any Justice of the Peace of the county in which said offence shall be committed, have the right of appeal to the Circuit Court of the county in which said offence shall be committed, under the same restrictions governing appeals from the decisions of Justices of the Peace.

Right of appeal.

SEC. 2. *And be it enacted*, That this act shall take effect from the date of its passage.

Effective.

Chapter 354, *Laws* 1880, *repeals Section* 10, *of Article* 41, *Code Public General Laws, title Fish and Fisheries, and re-enacts the same, as follows:*

SEC. 10. No float or other device for fishing shall be anchored or located at any place, so as to interfere with any shore fishery now used as such, or which may be hereafter established; nor shall any seine be hauled from such floats or other device over the ground usually hauled over by any shore fishery; nor shall any float haul over the grounds usually hauled over by another float, which has cleared its haul and been located in the same position two or more fishing seasons, unless the said float shall abandon for one spring the locality previously occupied; and any person or persons violating this section shall, for each offence, pay a fine of not less than twenty-five dollars nor more than one hundred dollars; and for every hour such float or other device shall remain anchored or located, after notice shall be given by the owner or occupant of such shore, float or fishery, requiring him to remove, he shall pay an additional fine of not less than ten dollars nor more than twenty-five dollars.

Not to interfere.

Penalty for violation.

PUBLIC LOCAL LAWS.

BALTIMORE COUNTY.

Chapter 95, *Laws* 1880, *protects fish in Middle River.*

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That it shall not be lawful for any person or persons to take any fish in Middle River and its tributary streams, or in the waters of the Chesapeake Bay within one mile of the entrance into the said Middle River, bounding on or lying within Baltimore county, by means of any seines or nets whatsoever.

Unlawful to catch fish.

SEC. 2. *And be it enacted*, That it shall not be lawful for any person or persons to fish in said waters with nets fastened to stakes, commonly known as pound, fyke or trap nets.

Use of nets, &c., prohibited.

SEC. 3. *And be it enacted*, That upon information given upon oath or affirmation to any Justice of the Peace having jurisdiction of any violation of any of the provisions of this act, he shall issue his warrant for the arrest of the offender or offenders, and for the seizure of the seines, nets, boats and other fishing outfit, to be directed to the sheriff or any constable of the county or other officer authorized to make arrests, or citizens, upon the receipt of said warrant to arrest any person or persons violating the provisions of this act, and to seize any such seine, net, boat or other fishing outfit, and found being used in violating any of said provisions, and to bring such offender or offenders before a Justice of the Peace most accessible or convenient, and upon conviction thereof the said offender or offenders shall be fined not less than twenty dollars nor more than two hundred dollars, one-half of such fine to be

Issue warrant for violation.

Violation—fine for.

paid to the use of the informer, and the other half to the use of the public schools of the county in which said offence was committed, and shall forfeit the seine, net, boat and other outfit used in such fishing, which shall be sold and the proceeds divided in such manner, and in case of non-payment of the fine and costs imposed by said Justice, the said offender or offenders shall be confined in the county jail for a period not exceeding forty days and not less than twenty days, or until said fine and costs are paid.

Sec. 4. *And be it enacted*, That any person or persons who may feel himself or themselves aggrieved by any judgment rendered by a Justice of the Peace under the provisions of this act, shall have the right to appeal to the Circuit Court of Baltimore county, upon condition and subject to the regulations now provided by the general law regulating appeals from Justices of the Peace, but execution of the judgment of the Justice of the Peace shall not be stayed, unless the party appealing shall give bond to the State in double the amount of fine imposed, with security approved by the Justice rendering the judgment, with conditions to prosecute his appeal with effect or to pay the fine imposed with all costs.

Right of appeal.

Effective.

Sec. 5. *And be it enacted*, That this act shall take effect from the date of its passage.

CALVERT COUNTY.

Chapter 179, *Laws* 1880, *protects fish in the waters of Battle, Hunting and St. Leonard's Creeks, Calvert County.*

Section 1. *Be it enacted by the General Assembly of Maryland*, That none but citizens of Calvert county shall, for any purpose whatsoever, haul a seine or seines, or any other instrument, in the waters of Battle creek, Hunting creek or St. Leonard's creek, in said county.

Who are allowed to haul seine.

SEC. 2. *And be it enacted*, That no person whatsoever shall haul a seine or seines, or any other instrument, in said waters of Battle creek, or use Hunting creek or St. Leonard's creek for the purpose of catching fish for sale, or for any other purpose than for home consumption.

Catching for sale prohibited.

SEC. 3. *And be it enacted*, That any person or persons violating either of the above sections of this act shall be deemed guilty of a misdemeanor, and upon conviction before a Justice of the Peace shall be fined not less than ten nor more than fifty dollars, one-half to be paid to the informer and the other half to the County Commissioners of Calvert county, for county purposes; and that either the State or the defendant shall have the same right of appeal from the judgments of said Justices as is now allowed in civil cases.

Penalty for violation.

SEC. 4. *And be it enacted*, That the boat and seine used by any person or persons violating either of the above sections of this act shall be responsible for the aforesaid fine.

Who is responsible.

SEC. 5. *And be it enacted*, That this act shall take effect from the date of its passage.

Effective.

CARROLL COUNTY.

Chapter 425, *Laws* 1880, *protects fish in waters of Carroll and Frederick Counties.*

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That it shall be unlawful for any person or persons to take, catch or destroy any fish in the waters of Frederick or Carroll counties except with hook and line, or by use of the dip net; provided that the Potomac river shall be exempted from the provisions of this act.

When unlawful.

SEC. 2. *And be it enacted*, That any one violating the provisions of the preceding section shall, upon conviction before a Justice of the Peace of said counties, be liable to a fine of

Fine for violation.

not less than five dollars nor more than ten dollars, for each offence, and upon failing to pay such fine and cost of prosecution shall be sentenced to imprisonment in the county jail of the county in which the offence has been committed for a period not exceeding ten days, said fine to be paid to the County Commissioners for the use of the county; provided, however, that any person so convicted shall have the right of appeal to the next term of the county court.

CECIL COUNTY.

Chapter 27, *Laws* 1880, *repeals Chapter* 449, *Laws* 1878, *and enacts the following in lieu thereof:*

Not lawful to lash or beat the waters.

1. It shall not be lawful for any person to lash or beat the waters of the Elk and Bohemia rivers with rods, poles or sticks, or any other instrument, or to make noises on the decks of any boat or any part of said boat for the purpose of driving fish into any net or seine within a half mile of Plum, Locust, Henderson's, Rich Neck, Welsh, Lorts or Oldfield's points on Heron island on the Elk river, or Town, Rich, Parlor, Long, Hackett's or George's point on the Bohemia river, when said points and island are occupied by persons engaged in gunning for wild fowl with decoys in the water nor within a half mile of the bridge over the Bohemia river when occupied by persons gunning for wild fowl from said bridge, unless the consent of such persons is first obtained to such fishing as aforesaid. Nor shall it be lawful to fish as aforesaid on the waters of the Elk and Bohemia rivers from the first day of April to the first day of September of each year.

Consent to be obtained.

Fines — how recovered.

2. Any person violating any of the provisions of this act shall, upon arrest and conviction thereof before a Justice of the Peace in and for Cecil county, be fined not less than ten nor more than twenty-five dollars, to be recovered as other small debts are recovered. And all

fines imposed under this act shall be divided as follows: one-half to the officer making the arrest, and the other half to the County Commissioners of Cecil county, to be applied by them to the use and benefit of said county. Fines—how disposed of.

SEC. 2. *And be it enacted*, That this act shall take effect from the date of its passage. Effective.

Chapter 197, *Laws* 1880, *repeals Section* 1, *Chapter* 134, *Laws* 1876, *and re-enact the same with amendments.*

1. On and after the passage of this act it shall be lawful for any owner, or owners, of land bordering upon the waters of the Elk, Sassafras and Bohemia rivers, and their tributaries, lying and being within the limits of Cecil county, or to whomsoever they may extend the privilege, to take or catch fish from nets or traps known as pound nets, except from the first day of June to the fifteenth day of September of each year; provided that such pound nets shall not extend to or across any channel, nor shall they be so placed as to, in anywise, obstruct the passage of any vessel or boat engaged in trading in said waters; nor shall any seine or net be used in that portion of said pound nets that confines the fish, the meshes of which are less than one and a quarter inches square; nor shall any stake or post be used in placing said pound nets of a greater diameter than four inches in the largest part; nor shall such stake or post be permitted to remain in said waters for a longer period than that prescribed in this act for the placing of said pound nets. When lawful. Size of meshes.

SEC. 2. *And be it enacted*, That this act shall take effect from its passage. Effective.

CHESTER RIVER.

Chapter 114, *Laws* 1880, *regulates catching fish in Chester River and its tributaries in Kent and Queen Anne Counties.*

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That it shall not be lawful for any person or persons to take, capture or destroy fish in the waters of Chester River or its tributaries in Kent and Queen Anne counties, by seines, drag-nets, set-nets, fish-baskets, fish-pots, weirs, pound-nets, fykes or any other means or contrivance whatsoever, which is now known or used in the capturing or destroying fish, or which may hereafter be invented for that purpose, from the tenth day of May to the first day of September, except with hook and line; provided, however, that seines or nets may be used for the taking of taylors and mackerel fish, provided the meshes of such nets or seines are in the bar not less than one and seven-eighth inches, or in the mesh less than three and three-quarter inches.

Unlawful to capture fish.

SEC. 2. *And be it enacted*, That it shall not be lawful for any person or persons who use stakes or poles in setting nets of whatever class or description, in the waters mentioned in the first section of this act, to leave such stakes or poles in the waters where they were used, but shall remove, or have removed, such stakes or poles from the waters where they were used, on or before the twentieth day of May in each year, nor shall they again be put down in said waters prior to the twentieth day of September following.

Unlawful to leave stakes in water.

SEC. 3. *And be it enacted*, That for any person or persons, in said waters, in the first section of this act, to empty their seines upon the beach or shore at any time whilst engaged in fishing, so as to leave the smaller fish to perish, but to empty the same in water of sufficient depth to enable the smaller fish to return to the waters for growth and maturation, and any person or persons using seines, pound-nets, fish-baskets, fykes, traps or nets of any class or description that catch the fish alive, shall immediately cull them and return the small fish to the waters at the place where they were taken.

Not to empty seines on the shore.

SEC. 4. *And be it enacted*, That no person or persons, other than the bona fide residents of Kent and Queen Anne counties, shall use any boat or trap of any kind or description used in catching fish in the said waters of Chester River and its tributaries in said counties; provided, however, that persons owning or occupying lands in said counties on said river and its tributaries, shall have the right to rent or otherwise grant to non-residents the privilege of fishing in or opposite their shores during the fishing season hereinbefore limited and fixed; and further provided, that the right to take fish with hook and line shall be allowed to all persons at all times.

Not to use boat or trap.

SEC. 5. *And be it enacted*, That upon the information of any citizen of either of said counties, that he knows or verily believes that any person or persons have violated any of the provisions of this act, before any Justice of the Peace of either of said counties, the said Justice of the Peace shall docket a case in the name of the State of Maryland against such person or persons so charged by oath as offending, and issue a warrant at once to some one of the constables or the sheriff of such county, for the arrest of the party or parties charged in said oath with such violation of this act, to be brought before such Justice for trial, and said constable or sheriff shall seize the boat, tackle, nets and other equipments owned by or in the possession of such person or persons so charged with the violation of this act, when such violation occurred, or at the time of such arrest, and safely keep such property so taken during the time pending the trial for such offence so charged, and if upon such trial the Justice of the Peace shall enter judgment for the State, such person or persons as against whom such judgment shall be rendered shall be fined not less than twenty nor more than fifty dollars for each and every offence, in the discretion of said Justice of the Peace; one-half of which fine shall be paid to the informer, the other

Docket case.

Seize boat, tackle, &c.

Fine for violation.

half to the school fund of the county where such judgment is rendered, and if such fine is not paid within five days from the date of said judgment, the said Justice of the Peace shall, on the sixth day thereafter, enter judgment of condemnation against the boat, tackle, nets, or other equipments of such offender which had been seized by the officer aforesaid, which said boat, tackle, nets or other equipments shall, after ten days' notice, be, by the said officer, sold to the highest bidder for cash, and from the proceeds of such sale shall deduct the fees allowed constables upon executions, the costs incident to such trial and judgment, together with such expense as such officer may have incurred in the taking and keeping of such property, and shall then divide the residue between the informer and the schools of the county equally, said officer not to be liable for any damage or loss of said property while in his custody which may occur without fault on his part.

Enter judgment.

How disposed of.

SEC. 6. *And be it enacted*, That if any person or persons convicted of offending against any of the provisions of this act shall think himself aggrieved by such conviction, he or they may appeal from the judgment of the Justice of the Peace before whom such conviction is had, at any time within ten days from the rendition thereof, to the Circuit Court of the county in which the trial was had. If any resistance be made to the officer directed to execute this act by any person or persons offending against the same, the said officer shall summon the posse comitatus and proceed therewith without delay to execute his duty under such warrant. The Justice before whom such offender or offenders shall be taken shall have full power to issue summons for all witnesses that be named to him, to compel their appearance and examine them under oath.

Right of appeal.

SEC. 7. *And be it enacted*, That all acts or parts of acts inconsistent with this act be and

the same are hereby repealed, and that this act shall take effect from the date of its passage. Inconsistent acts repealed.

FREDERICK COUNTY.

See Carroll County.

HARFORD COUNTY.

Chapter 194, *Laws* 1880, *repeals Section* 1, *Chapter* 41, *Laws* 1867, *and re-enact as follows:*

Sec. 2. *And be it enacted*, That it shall not be lawful for any person to whip or beat the waters of Romney creek, in Harford county, with poles, sticks, or any other thing for the purpose of driving fish into seines, fish baskets, or any other contrivance for catching fish; nor shall it be lawful for any person, at any time, to do said acts, or any other thing for the purpose, or which will have the effect of frightening or driving wild ducks or other wild waterfowl from their feeding or roosting grounds in said creek; nor shall it be lawful for any person, at any time, between the first day of October and the fifteenth day of March, in each and every year, to erect any fish pot, or to fish with any drag net, fish basket, or any other snare, for fish, in the waters of said creek. Unlawful to whip or beat waters.

KENT COUNTY.

See Chester River.

PATAPSCO RIVER.

Chapter 76, *Laws* 1880, *repeals Section* 1, *Chapter* 79, *Laws* 1874, *and re-enacts the same with amendment, as follows:*

Section 1. *Be it enacted by the General Assembly of Maryland*, That from and after the passage of this act it shall not be lawful for any person or persons to take, capture or destroy fish by seine or seines, drag-net or drag-nets, set-net or set-nets, dip-net or dip-nets, stir-net or stir-nets, fish baskets or fish pots, eels weirs, Unlawful to capture fish by seines, &c.

brush or fascine nets, or any means or contrivances whatever of the nature of a seine, which are known to destroy or capture fish, or to destroy or capture them by shooting or striking through the ice, or otherwise, than by hook and line, commonly known as angling, in the Patapsco river, above the point where the old turnpike road from Baltimore to Washington crosses the said river.

Effective.

SEC. 2. *And be it enacted*, That this act shall take effect from the date of its passage.

QUEEN ANNE COUNTY.

See Chester River.

SOMERSET COUNTY.

Chapter 379, *Laws* 1880, *prevents catching fish except in certain cases in Coulbourn's Creek.*

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That it shall be unlawful for any person to take or catch, or destroy, in any manner whatever, fish in the waters of Coulburn's creek, in Somerset county, with any kind of seine, net or weir, except such nets as are used for catching rock fish, during the months of March, April and May, which said last mentioned net shall not exceed in length twenty fathoms; but nothing herein shall be construed to prevent fishing with hook and line.

Unlawful.

SEC. 2. *And be it enacted*, That any person or persons who may violate the provisions of this act shall, upon conviction thereof before any Justice of the Peace for said county, be fined for each and every offence the sum of twenty dollars, and to stand committed in the county jail until the fine and costs are paid.

Fine for violation.

SEC. 3. *And be it enacted*, That any person feeling aggrieved by any decision under the provisions of this act shall have the right to appeal to the Circuit Court for said county.

Right of appeal.

SEC. 4. *And be it enacted*, That this act shall take effect from the date of its passage. Effective.

WASHINGTON COUNTY.

Chapter 322, *Laws* 1880, *repeals Sections* 102 *and* 103, *Code Public Local Laws*, *title Washington County*, *sub-title Fish*, *and re-enacts as follows:*

102. It shall not be lawful for any person to whip or beat the water in the Antietam creek or its tributary streams, Beaver creek, Long Meadow branch and Little Antietam, with poles, sticks or other things, for the purpose of driving the fish into nets, seines, fish baskets or other snares, or to erect any fish pot, or to fish with any net, basket, gig, trot line, or in any other manner, except with the angling rod and dip-nets. Unlawful acts.

103. Any person offending against the provisions of the last preceding section shall be arrested and taken before a Justice of the Peace, and on conviction, shall forfeit and pay for each offence, and for each month a fish pot may be suffered to remain in any of the streams aforesaid, a fine, not exceeding the sum of twenty dollars, and in default of payment of such fine shall be committed to the county jail for a term not exceeding sixty days, the said fine to be recovered in the name of the County Commissioners of Washington county, before a Justice of the Peace, one-half to be paid to the informer and the other half to the school fund of said county; provided that any person feeling himself aggrieved by the judgment rendered by any Justice of the Peace, in proceedings under the provision of this and the last preceding section, shall have the right to appeal from said judgment to the Circuit Court for Washington county. Fine for violation.

SEC. 2. *And be it enacted*, That this act shall take effect from the date of its passage. Effective.

WICOMICO COUNTY.

Chapter 448, *Laws* 1880, *protects fish in waters of Wicomico County.*

Unlawful to use pound net, &c.

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That it shall be unlawful for any person or persons to set, stake, or in any manner place any pound net or fyke net made of twine, in the waters of Wicomico county, at any time.

Not to catch, capture, &c.

SEC. 2. *And be it enacted*, That it shall be unlawful for any person or persons to catch, take, capture, kill or injure any shad, herring, rock, perch or any other kind of fish with haul seine, float seine, stake seine, or any other kind of seine, net or fish trap in the waters of said county, between the twentieth day of May in each and every year, and the first day of September in the next succeeding year.

Fine for violation.

SEC. 3. *And be it enacted*, That each and every person who may violate any of the provisions of this act shall be deemed guilty of a misdemeanor, and upon conviction thereof, before any Justice of the Peace of Wicomico county, shall be fined by the said Justice of the Peace sitting in the case a sum not less than ten dollars nor more than twenty-five dollars, for each and every violation aforesaid; and each and every person so convicted and fined shall be committed by the said Justice of the Peace to be confined in the county jail in said county until the said fine and all costs of the prosecution are paid; and shall, in addition to the said penalties, also forfeit and lose all seines, nets and boats of every kind which may be used by them in violating as aforesaid.

Sell forfeited property.

SEC. 4. *And be it enacted*, That it shall be the duty of the Justice of the Peace to decree the forfeiture mentioned in the preceding section, and to order and direct the constable or other officer making the arrest, to take and sell any property so forfeited as aforesaid, after

first giving at least ten days' notice by advertisement inserted in some newspaper published in said county, or by advertisement posted in three of the most public places in the neighborhood in which the offender may live, of the time and place of sale, and the said sale shall be for cash; and after deducting all costs and charges of advertising and making said sale, the balance of the proceeds of said sale shall be equally divided, and one-half thereof shall be paid by the officer collecting the same to the informer, and the other half shall be paid by said officer to the treasurer of the school board, for the use and benefit of the public schools in said county.

SEC. 5. *And be it enacted*, That any person or persons feeling aggrieved by the decision of the Justice of the Peace made and given under the provisions of this act, shall have the right to appeal to the Circuit Court for said county, and shall be notified of the said right of appeal, by the said Justice of the Peace, at the conclusion of the proceedings before him; provided, however, that no appeal shall be granted as aforesaid, unless the person so appealing shall first, within ten days after the entering of the judgment of the said Justice of the Peace, give a full and sufficient bond, with two good and responsible sureties, to be approved by the said Justice of the Peace to the State of Maryland, with condition to prosecute said appeal to the said Circuit Court at its next session thereafter, and also to pay the fine already imposed, together with all the costs, both before the Justice of the Peace and the Circuit Court, in the event the said judgment shall be affirmed.

Right of appeal.

SEC. 6. *And be it enacted*, That on information being given on oath to a Justice of the Peace of said county that a violation of any of the provisions of this act has been, or is being committed by any person or persons, the said Justice of the Peace shall forthwith issue his

Issue warrant for arrest.

warrant, in the name of the State of Maryland, for the arrest of the offender or offenders, which warrant shall be directed to the sheriff or some constable or baliff in said county, and the officer receiving said warrant may summon the posse comitatus, when necessary, to aid him in making any arrest under this act.

How construed.

SEC. 7. *And be it enacted*, That nothing in this act shall be so construed as to prevent any of the citizens of Wicomico county from catching or trapping fish in any of the waters of said county, for private use, at any time of the year.

Effective.

SEC. 8. *And be it enacted*, That all acts and parts of acts inconsistent with the provisions of this act be and the same are hereby repealed, and that this act shall take effect from the date of its passage.

WORCESTER COUNTY.

Chapter 223, *Laws* 1880, *regulates fishing in Synepuxent Bay.*

Unlawful to set seines, &c.

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That it shall be unlawful for any person or persons to place any set seine or seines, or any seines or nets in any manner rendered stationary, in that part of the waters of Synepuxent bay, north of South Point, Isle of Wight bay, Assawoman bay and Saint Martin's river, which is located equally at all points on either side of a line drawn through the centre of each of said waters, from the northern to the southern extremity thereof, and extending in width at all points of said line one-third part of the distance which separates the opposite shores of the waters aforesaid, at said points; and all seines or nets used in violation of this act shall be forfeited and sold as hereinafter directed.

Unlawful to haul with seine.

SEC. 2. *And be it enacted*, That it shall be unlawful for any person or persons to haul or fish with any haul or set seine or seines, or to

leave or to permit to remain setting, any set seine or seines in any part of the waters of Synepuxent bay and its tributaries, north of South Point, during the interval from the hour of six o'clock P. M. of Saturday of each week until the hour of six o'clock A. M. of the following Monday.

Sec. 3. *And be it enacted*, That no person shall catch by means of a seine or seines any perch fish of not less than a fourth of a pound each in the waters described in the preceding section. Weight specified.

Sec. 4. *And be it enacted*, That any person violating any of the provisions of this act shall be guilty of a misdemeanor, and upon conviction thereof before a Justice of the Peace for Worcester county, or in the Circuit Court of the same county, shall be fined not less than five or more than twenty dollars, and be imprisoned until said fine and all costs in the case are paid; provided said imprisonment shall not exceed thirty days in any event. Fine for violation.

Sec. 5. *And be it enacted*, That upon information given upon oath to any Justice of the Peace of Worcester county of any violation of any of the provisions of this act, the said Justice shall issue his warrant for the arrest of the offender or offenders, and the seizure of the seine or seines used in violation of this act, which warrant shall be directed to the sheriff or any constable of Worcester county, requiring said offender or offenders to be brought before him, and also all seines used in violating this act, whether the owner of the same be known to him or not. Issue warrant.

Sec. 6. *And be it enacted*, That it shall be the duty of any Justice of the Peace of the county aforesaid, before whom it shall be proven satisfactorily that any nets or seines have been used in violation of this act, to cause such nets or seines to be sold at public auction to the Sell at auction.

highest bidder for cash, after giving ten days' notice of the time and place of such sale in at least two public places in the vicinity of said sale, and one-half of all fines collected under this act shall go to the informer, and the other half to the school fund of Worcester county.

TERRAPINS.

Chapter 462, *Laws* 1880, *repeals Section* 2, *Chapter* 424, *Laws* 1878, *and re-enacts the same, as follows :*

Unlawful to catch or take.

SECTION 2. *Be it enacted*, That it shall be unlawful for any person or persons to take or catch from the waters of this State, any diamond back terrapins of a less size than five inches in length upon the bottom shell, at any time, provided that the provisions of this section shall not apply to Worcester and Dorchester counties.

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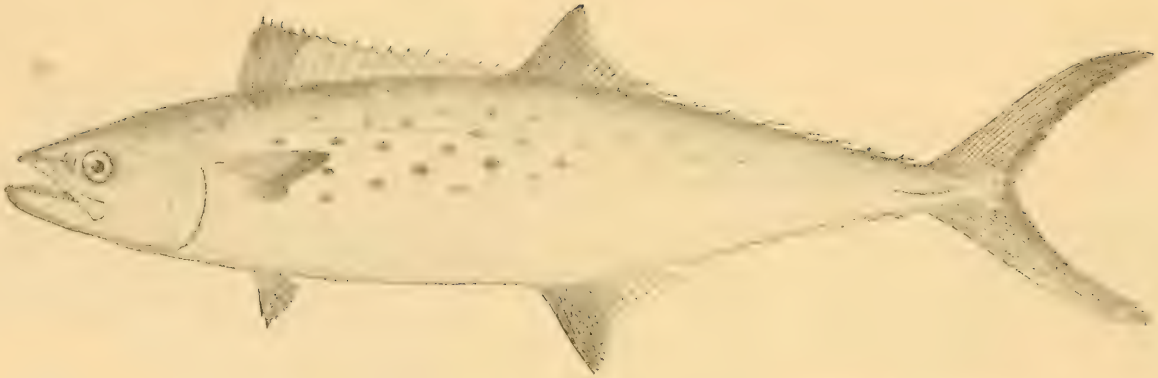
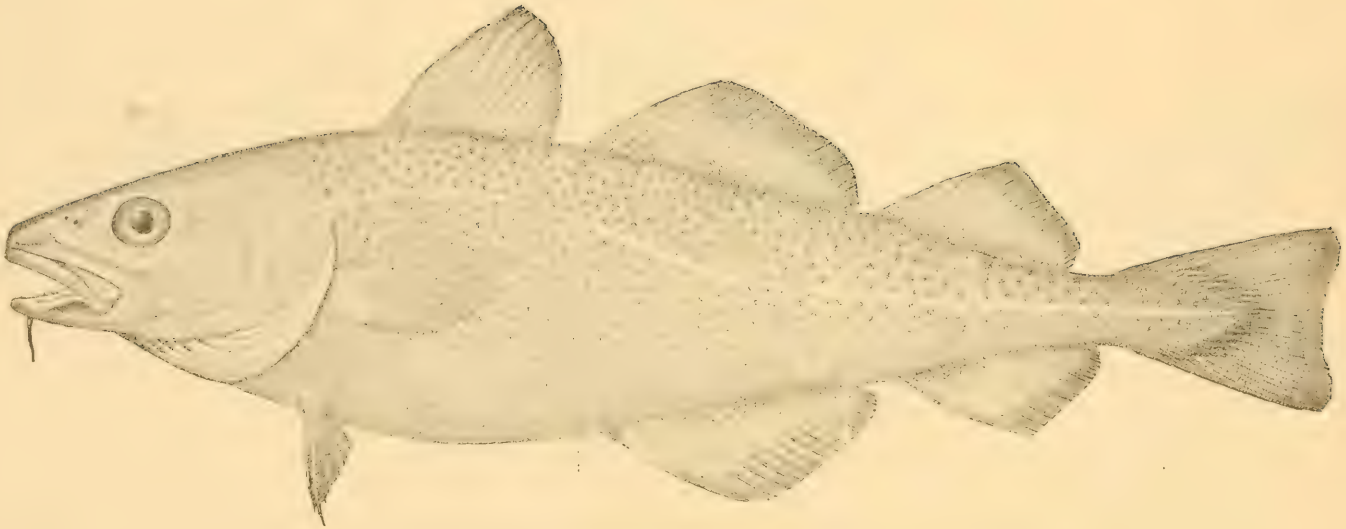
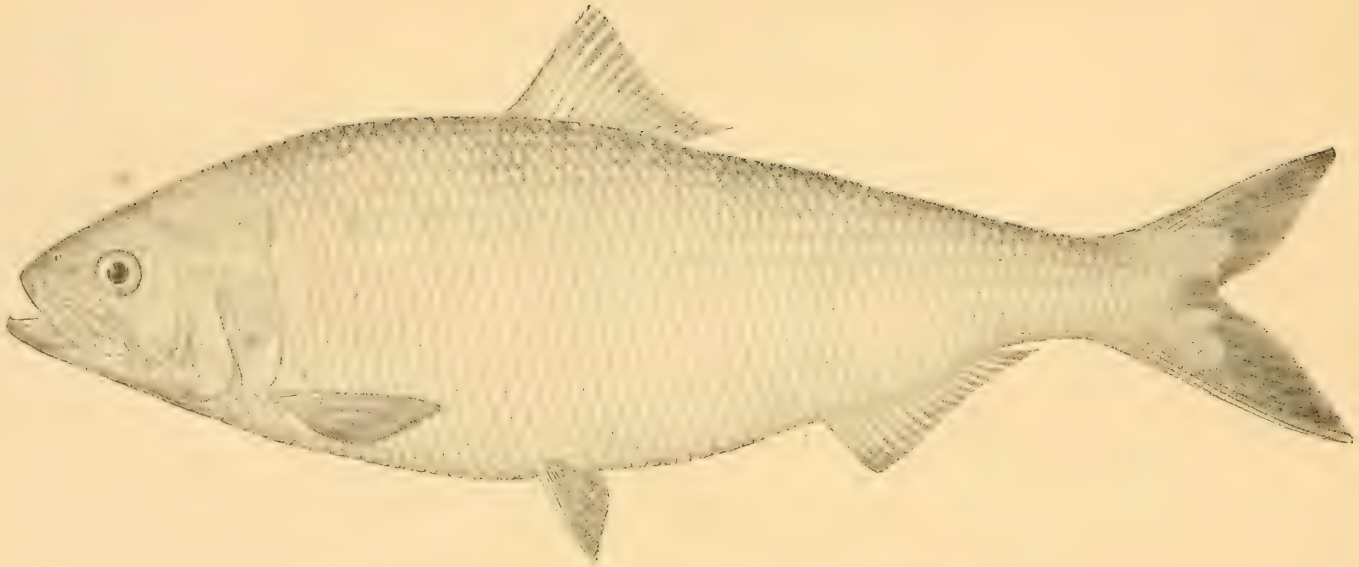


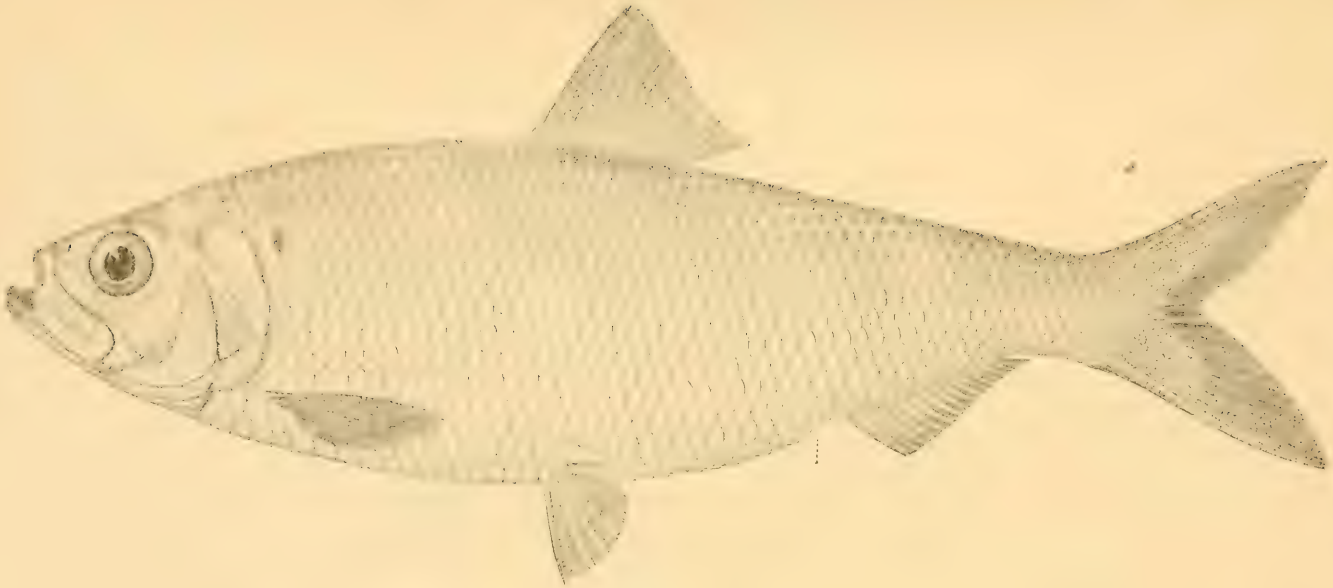
SPANISH or BAY MACKEREL, (½ natural size.) *Cybium maculatum.*



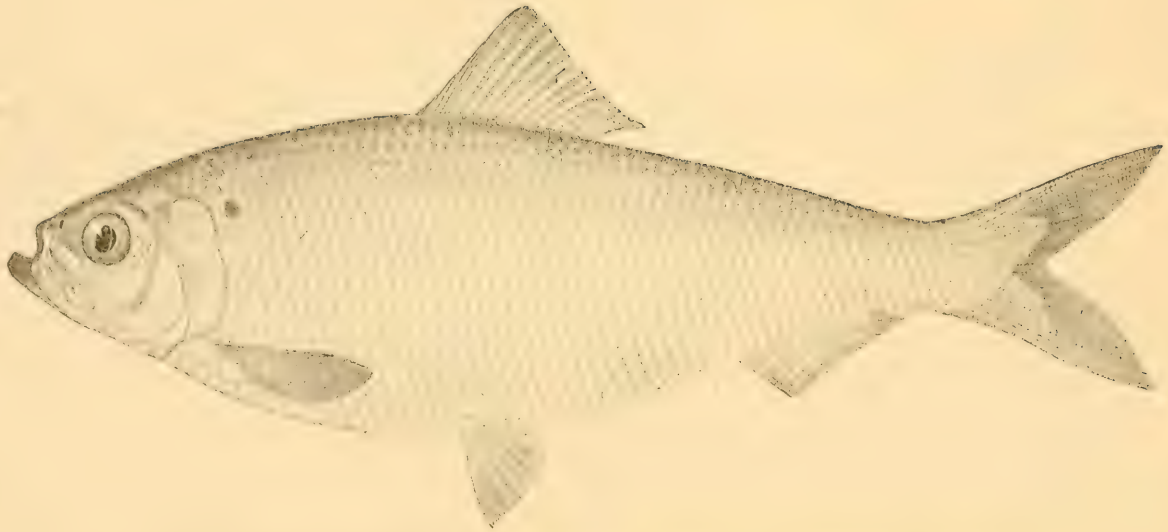
COD-FISH, (a little over ⅛ natural size) *Gadus morrhua.*



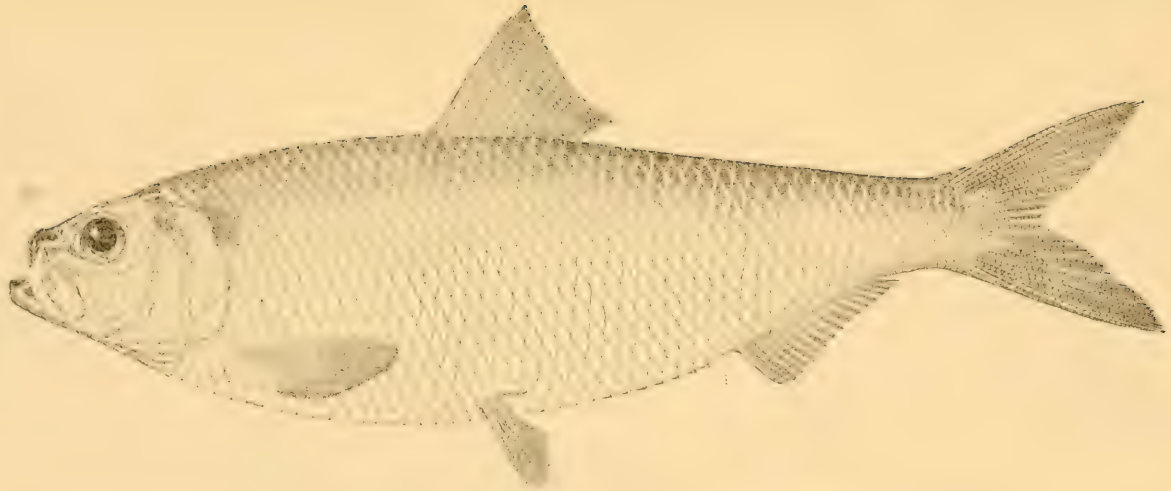
SHAD, (a little more than ½ natural size.) *Alosa sapidissima,* (*male.*)



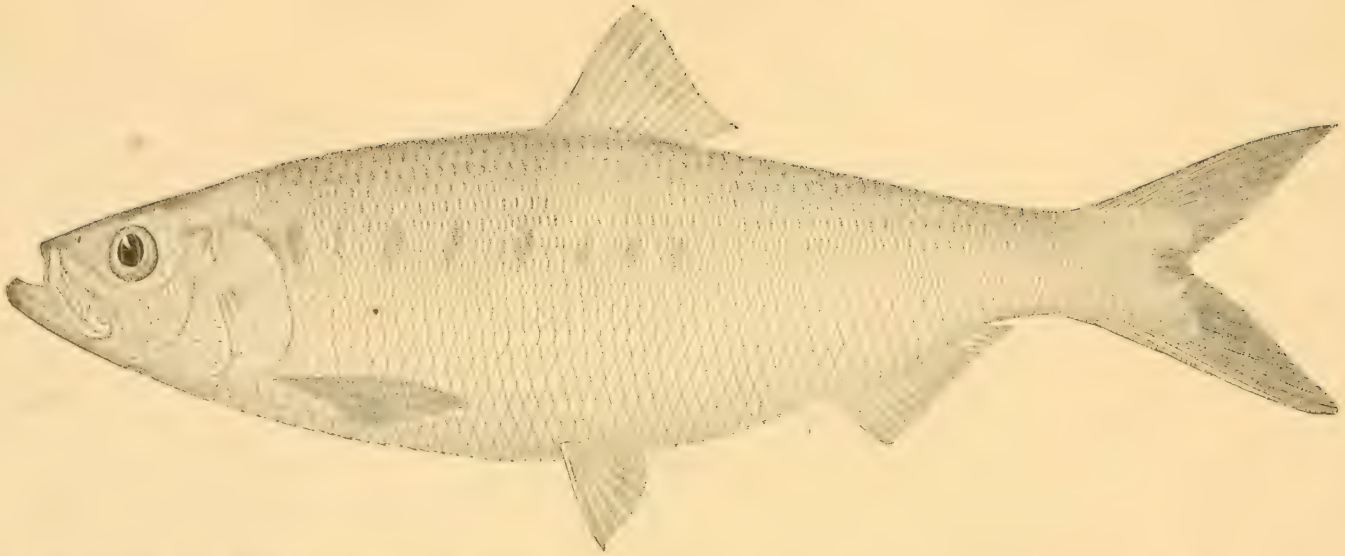
BRANCH-HERRING, (⅔ natural size.) *Pomolobus vernalis, (male.)*



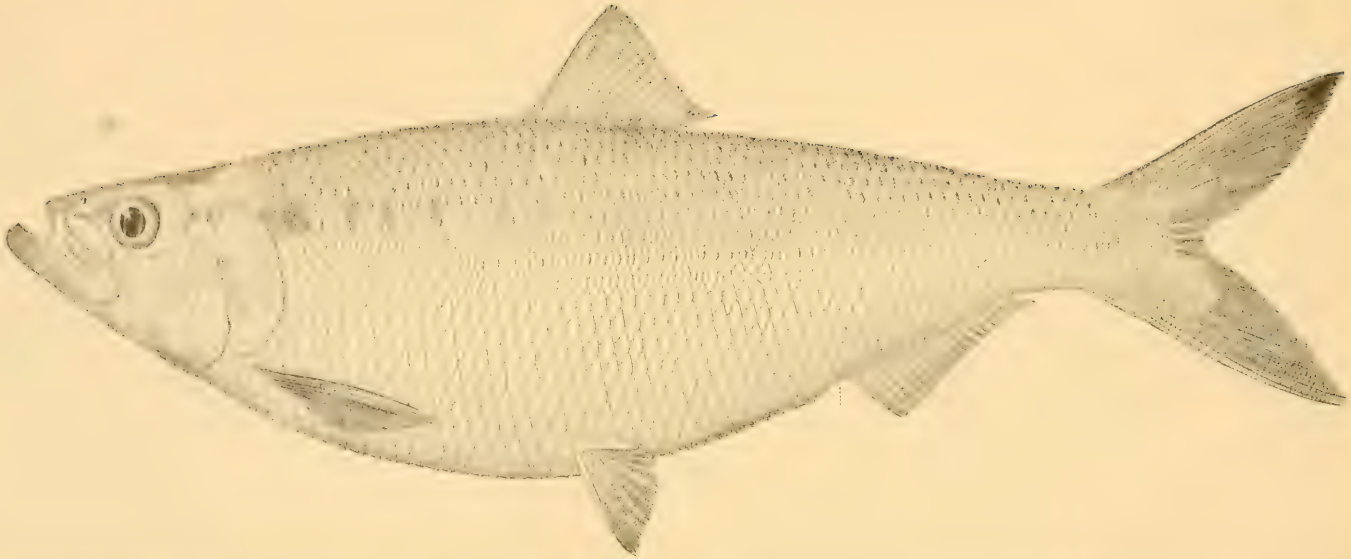
BRANCH-HERRING. (½ natural size.) *Pomolobus vernalis (female.)*



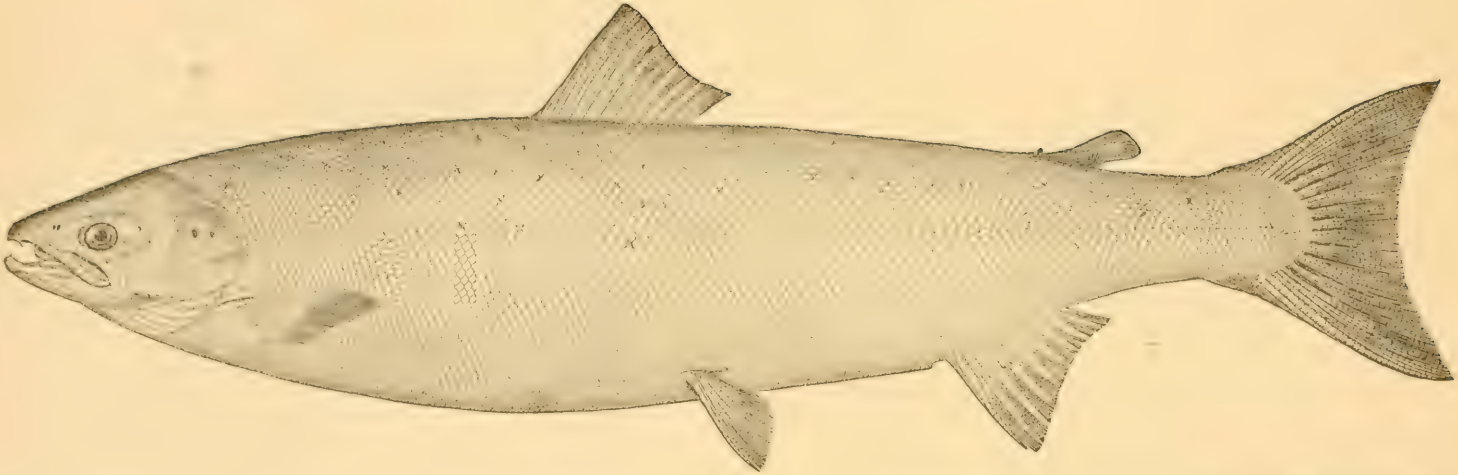
GLUT-HERRING, (½ natural size.) *Pomolobus æstivalis* (male.)



AUTUMNAL HERRING or TAILOR SHAD, a little less than ½ natural size.) *Pomolobus mediocris, (male.)*

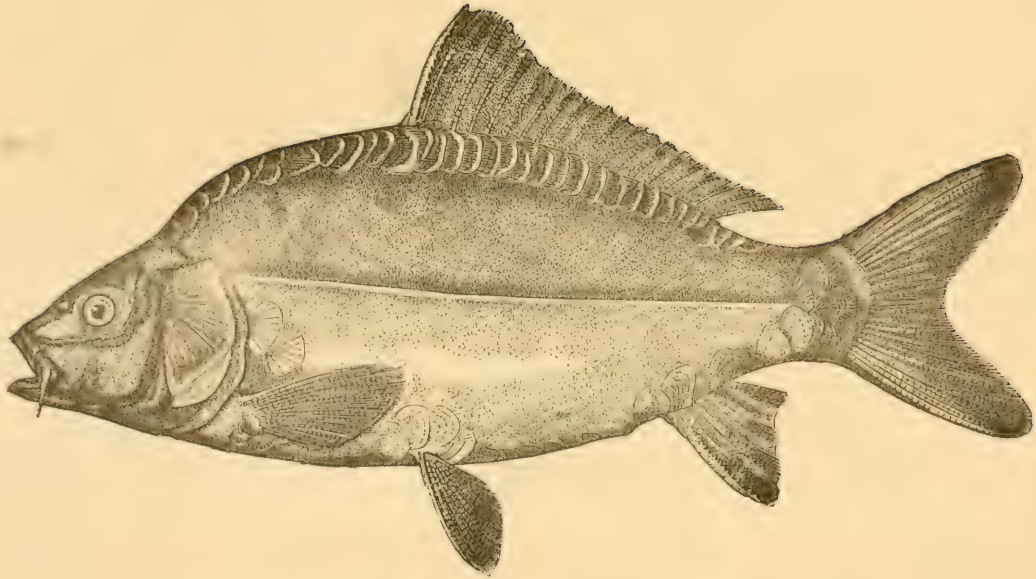


AUTUMNAL HERRING or TAILOR SHAD. (a little over ½ natural size.) *Pomolobus mediocris.* (*female.*)

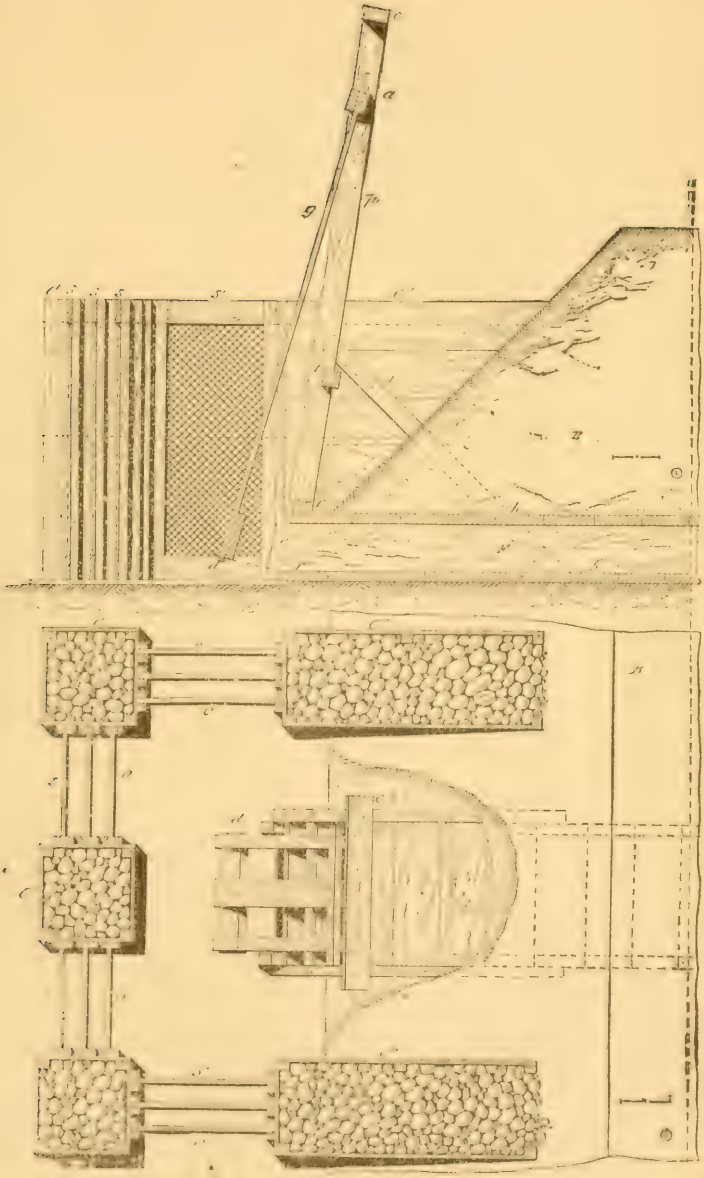


SALMON, Salmo salar, taken near Spesutie Island, Md., on the 11th of May, 1878. Length, 3' 4". Weight, 19 lbs.

CALIFORNIA SALMON. (1-5 natural size.) *Oncorhynchus quinnat.*



LEATHER CARP, (1/8 natural size.) *Cyprinus Carpio.*



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